



EUROPEAN CENTRAL BANK
BANKING SUPERVISION

Risks from misalignment of banks' financing with the EU climate objectives

Assessment of the alignment of the
European banking sector

BANKENTOEZICHT

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The risks stemming from the transition towards a decarbonised economy can have a significant effect on the credit portfolio of a financial institution. These transition risks are drivers of credit, market, operational and liquidity risk. Corporations in energy-intensive or CO₂-intensive sectors to which financial institutions supply credit could experience reduced competitiveness as the transition towards a decarbonised economy takes place. This is especially the case for corporations that have not been making efforts to adjust to a decarbonised economy. The reduction in a corporation's market competitiveness may result from higher carbon prices, greater dependency on energy prices, asset stranding, stricter environmental regulations and changing consumer preferences, ultimately leading to a rise in its default risk. The risk of default is highest in a delayed transition scenario, which would require abrupt government action and rapid adjustment by corporations. Defaults such as these can lead to unexpected additional losses for financial institutions. Moreover, many financial institutions depend to a large extent on providing credit to corporations in energy-intensive sectors, which generate the majority of their interest income. It is thus vital for financial institutions to assess the risks arising from the transition towards a decarbonised economy. Transition risks are not only present in an institution's credit portfolio, but can also affect its security holdings. This report focuses on the transition risks stemming from banks' credit portfolios.

If the transition towards a decarbonised economy becomes disorderly, there will be a growing need to quantify the transition risks in banks' credit portfolios. Alignment assessment measures the difference between a corporation's production projection and targets set under a decarbonisation pathway. When a corporation is misaligned, it is adjusting its production more slowly than required under the decarbonisation pathway. Alignment assessment is widely recognised as a useful method for quantifying transition risks in a credit portfolio, alongside techniques like scenario analysis, stress testing, exposure analysis and determining financed emissions. While these other methods give an indication of the carbon intensity of a credit portfolio at a certain point in time, alignment assessment provides insight into whether the corporations in a credit portfolio are moving towards low-carbon production. Banks and regulatory and supervisory authorities alike are currently embracing alignment assessment as a tool for evaluating risks and exploring strategies that have a positive impact on the climate. The adoption of alignment assessment is increasingly driven by its forward-looking nature and ability to factor in a corporation's capacity to align its production capabilities with the transition. Supervisors are also using alignment assessment, as demonstrated by the European Central Bank (ECB) in its 2022 thematic review on climate-related and environmental risks conducted. This approach provided key insights into the ability of banks to assess transition risk within their credit risk management processes.

Based on forward-looking production data for assets within the sectors most impacted by the shift towards a low-carbon economy, this report assesses the risk stemming from the (mis)alignment of banks' financing with EU policy objectives. An alignment assessment is conducted using the open-source Paris Agreement Capital Transition Assessment (PACTA) methodology to determine bank-wide alignment rates. Transition risks are assessed for fifteen different technologies in six key transition sectors, together accounting for around 70% of CO2 emissions. These sectors are set to undergo the bulk of the transition process and have therefore been identified as having the most pronounced transition risks. As it relies on corporates' production plans, the PACTA methodology has a forward-looking horizon of five years. This indicates whether a corporation is transitioning towards low-carbon production or rather continuing with carbon-intensive technologies and the degree to which the pace of transition is consistent with a given policy objective. Alignment is measured by comparing the rate of change in technology deployment to the rate of change required under a decarbonisation pathway. Under the PACTA framework, a variety of pathways can be applied depending on the target. The European Climate Law¹ requires the European Union (EU) to achieve carbon neutrality by 2050. The International Energy Agency's "Net Zero Emissions by 2050" decarbonisation pathway is aligned with this objective and can serve as a benchmark for the global energy sector to attain net-zero CO2 emissions by 2050. To assess and benchmark alignment at bank level, the technology-level (mis)alignments from PACTA are aggregated to present a net alignment rate for a given bank. In the future, this approach to alignment assessment could be further developed to cover a broader array of sectors, such as shipping and aviation, as well as other types of risk, for example market risk.

The euro area banking sector shows substantial misalignment and may therefore be subject to increased transition risks, and around 70% of banks are also subject to elevated reputational and litigation risk. This can be seen by applying alignment assessment to the euro area banking sector² using AnaCredit data for financial institutions' loan portfolios and the Physical Assets Matched with Securities (PAMS) dataset from the provider Asset Impact. Around 5% of credit to non-financial corporates is issued to the six transition sectors analysed. The methodology can also be extended to other sectors and can thus cover a larger percentage of financial institutions' credit portfolios. Furthermore, banks' exposures to misaligned counterparties can increase by more than 50% if the credit lines to these counterparties are fully utilised. Based on the six sectors analysed, it is already clear that there is a pressing need for a significant transformation in the euro area production infrastructure financed by euro area banks in terms of alignment with the targets set out in the Paris Agreement. Chart 1 illustrates that, among the 95 significant institutions analysed, a staggering 90% are found to be misaligned, with varying levels of exposure and misalignment. All of these banks could experience transition risks, primarily in the form of elevated credit risk, as the competitiveness of

¹ Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law') (OJ L 243, 9.7.2021, p. 1).

² As AnaCredit data is used, the analysis is limited to euro area banks and their euro area subsidiaries. Non-euro area subsidiaries are not included in AnaCredit data. The assessment is limited to credit exposures to corporations that are active in the six key transition sectors.

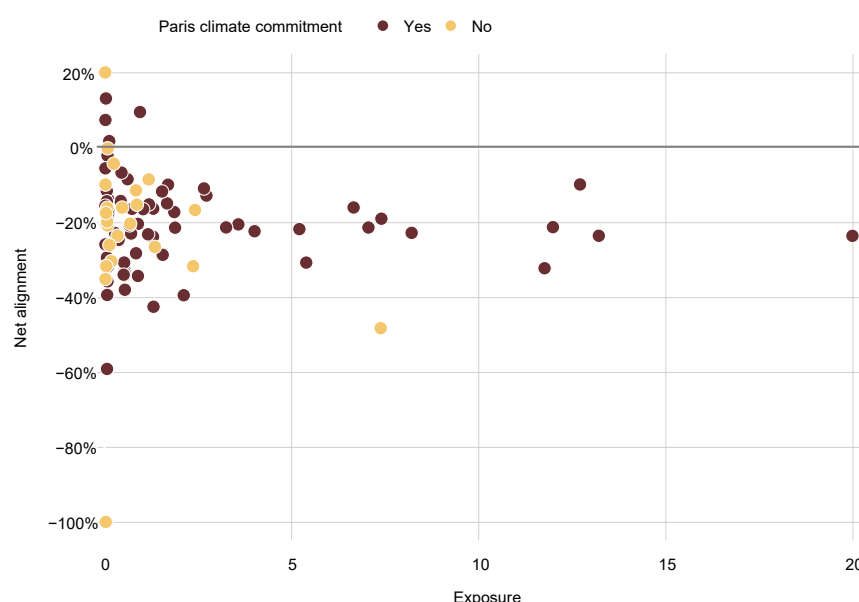
the corporations to which they provide credit would be reduced, leading to potential credit losses as a result of the higher probability of default. Additionally, seven in ten banks are exposed to elevated legal risk, as they have committed to the Paris Agreement, but their credit portfolio is not aligned with it. Moreover, some of the most misaligned credit portfolios have a relatively high exposure compared with their CET1 capital, suggesting a potential impact on solvency for the credit-issuing institutions.

Chart 1

Net alignment of euro area banks with and without Paris commitment

Breakdown by bank, exposure volume and by banks' commitment to achieving the Paris Agreement goals

(net alignment in percentages, exposure in EUR billions)



Sources: IEA, AI, RMI and ECB calculations.

Notes: Each dot represents one significant institution. The net alignment is computed using the IEA NZE 2050 scenario for the oil and gas, coal mining, power generation, automotive, steel, and cement sectors. Net alignment of higher than 20% is reduced to 20%, and net alignment of lower than -100% is raised to -100% for visualisation purposes.

A more in-depth analysis reveals the underlying factors contributing to the elevated transition risk in credit portfolios, which largely stems from financing counterparties that are either too slow to phase out their high-carbon production capacities or too slow to build out their renewable energy production capacity. Banks are providing larger loans to misaligned corporations, with the average size of an exposure to a misaligned corporation being more than double that of an aligned corporation. Because the net alignment is exposure-weighted, the discrepancy in funding leads to the finding that almost all banks exhibit misalignment in nearly every sector, with the exception of the steel industry.³ The power sector is the primary driver of this misalignment. Banks are predominantly financing corporations that are either struggling to keep up with building out renewable power generation in the power sector or falling behind in the phasing out

³ As the steel sector is hard to decarbonise, the required transition for the sector is smaller in 2027, leading to lower possible misalignment.

of conventional automotive production. While for the oil and gas sector, production is declining within the euro area, banks are continuing to finance the expansion of production outside the euro area. Since the transition necessitates moving away from oil and gas use, oil and gas production assets might become stranded. Banks are extending credit to corporations for electric vehicle production, which are then aligned with the decarbonisation pathway. However, internal combustion engine car production shows little sign of being phased out. Over 50% of the total misalignment can be attributed to corporations that are being slow to phase out carbon-intensive technologies. Over 30% of the euro area banking sector's misalignment stems from insufficient financing of renewable energy sources. Most banks are thus facing elevated risks, particularly the risk of asset stranding, as the phase-out of carbon-intensive technologies is often lagging.

Banks can apply the approach used in this report to further develop their alignment assessment capabilities to help determine the transition risks they face as well as meet the impending disclosure requirements under the European Banking Authority's Implementing Technical Standards (EBA ITS) on Pillar 3. The ECB's 2022 thematic review on climate-related and environmental risks found that banks have started to use transition planning tools, including alignment assessment, to deepen their understanding of the additional risks in their credit portfolios resulting from the transition towards a decarbonised economy. Banks are broadly adopting client engagement approaches geared towards reducing risk and financing the transition. While some banks use exclusions, others are adjusting their credit policies to shift their portfolios more into line with the required build-out and phase-out of specific technologies. Alignment assessment can be a valuable tool for identifying which clients face the greatest transition risks and for quantifying those risks. This makes alignment assessment a useful tool for financial institutions and supervisors alike. Moreover, banks that fall within the scope of EBA ITS on Pillar 3 disclosures on environmental, social and governance (ESG) risks will have to disclose the alignment of their credit portfolios by the end of 2024 at the latest, including their degree of deviation from a decarbonisation pathway. The methods set out in this report provide a concrete approach for banks to follow in meeting this requirement.

2 Introduction

Transition risks arising in the context of a move toward a decarbonised economy refer to the potential negative impacts on a financial institution's credit portfolio. These risks emerge owing to changes in the economic landscape as society shifts away from carbon-intensive industries towards cleaner and more sustainable practices. As the transition to a decarbonised economy progresses, corporations in energy or carbon-intensive sectors may face growing challenges, which can make them more likely to default on their financial obligations or increase the loss given default through reduced collateral value. There are various reasons for this heightened default risk, including factors such as stricter environmental regulation, an increasing carbon price, declining demand for carbon-intensive products, increased dependency on energy prices, or the emergence of new environmentally friendly technologies, all of which could disrupt corporations' business models. For instance, a global shift away from fossil fuels to meet Paris Agreement targets is expected to render about 80% of fossil fuel reserves stranded, entailing substantial losses.⁴ The risk of default becomes particularly pronounced when the transition is more abrupt or disorganised, especially within the energy and mining sectors.⁵ Many financial institutions have a significant portion of their loan portfolios tied to corporations operating in energy-intensive sectors. Such loans are a substantial source of interest income for these institutions,⁶ leaving them potentially at risk if the corporations do not transition quickly enough. While the main source of transition risk results in an increase in credit and reputational risk, increases in market, liquidity and operational risks are also possible.⁷

Assessing alignment is broadly accepted as an approach for identifying and quantifying banks' transition risks.⁸ Through alignment assessment, the compatibility of banks' financing of physical production capacities with the Paris Agreement can be determined in a forward-looking manner. Alignment refers to the percentage difference between the production plan of a corporation and production that is aligned with a pathway aimed at achieving the Paris climate goals. Chart 2.1 provides an overview of how alignment is assessed. To the extent that misalignments with a Paris-compatible decarbonisation trajectory can be observed, elevated risks arise from, among other things, policy action and technological shifts geared towards achieving the Paris goals. Similarly, financing corporates that continue to rely on carbon-intensive production capacities is likely to harm the competitive position and profitability of both the counterparties and the financing

⁴ See Bos, K. and Gupta, J., "Stranded assets and stranded resources: Implications for climate change mitigation and global sustainable development", *Energy Research & Social Science*, Vol. 56, 2019.

⁵ See Emambakhsh, T., Fuchs, M., Kördel, S., Kouratzoglou, C., Lelli, C., Pizzeghello, R., Salles, C. and Spaggiari, M., "The Road to Paris: stress testing the transition towards a net-zero economy", *Occasional Paper Series*, ECB, September 2023.

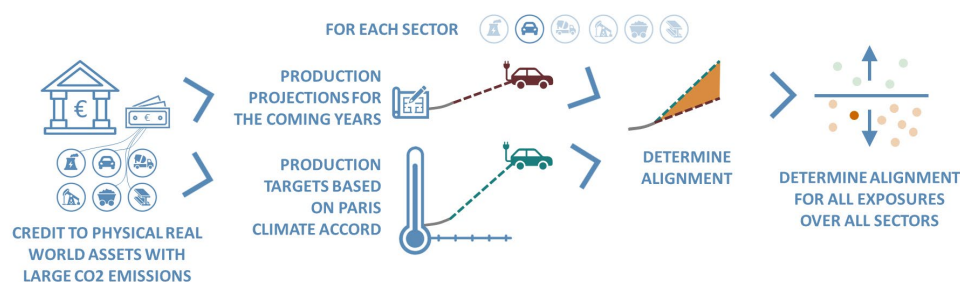
⁶ ECB, *2022 climate risk stress test*, July 2022.

⁷ Basel Committee on Banking Supervision, "Climate-related risk drivers and their transmission channels", April 2021.

⁸ EBA, *Report on management and supervision of ESG risks for credit institutions and investment firms*, June 2021.

institutions. Moreover, the financing of activities that are counterproductive to the transition is coming under growing scrutiny from interest groups and other stakeholders, potentially leading to an increase in reputation and litigation risks for banks and their clients, in particular when either the bank or the client have made public climate commitments.

Chart 2.1
Assessment of alignment



Source: ECB.

Note: The assessment of alignment refers to the difference between the required change in a corporations' production to align with the Paris Agreement and the projected production based on a corporations' concrete plans. Chart 2.1 illustrates the process of determining alignment for an exposure in the automotive sector.

Alignment assessments were applied by the ECB at counterparty level, providing key insights on the ability of banks to assess transition risk in their credit risk management. In this context, supervisors conducted case interviews with banks to assess whether their policies and procedures are effectively implemented in practice. Supervisors used corporation-level alignment assessments to inform various banks and assess pockets of elevated risks.⁹ This led to the identification of new transition risks for banks, and allowed supervisors to gain experience with evaluating transition risk in credit portfolios. Alongside the individual counterpart level assessments conducted in the 2022 thematic review, alignment assessment can provide insight into the transition risks of both individual banks and the banking sector as a whole. This report sets out a methodology for assessing alignment and applies it to the euro area banking sector. It demonstrates how alignment assessment can be used by both financial institutions and supervisors alike to gain insight into the transition risk in a credit portfolio and how these risks can be further analysed. In the opening chapter, the report provides information on the assessment of alignment and sets out the methodology. In Chapter 4, the methodology is applied to banks in the euro area that are supervised by the ECB and which have exposures in the six key transition sectors. The results are analysed in several ways. The final chapter takes a closer look at how financial institutions can use, and in some cases are already using, alignment assessment to reduce their transition risks.

⁹ ECB, "Walking the talk: Banks gearing up to manage risks from climate change and environmental degradation", November 2022.

3 Assessment of alignment

Both banks and supervisors are currently applying alignment assessment as a tool to determine transition risk. Banks also use it to devise ways of reducing their environmental impact.

The 2023 ECB review of climate-related and environmental risk disclosure practices and trends indicated that 32% of the banks falling within its scope disclosed the results of their portfolio-level alignment assessments, giving insight into the transition risks of the banks themselves.¹⁰ The 2022 thematic review on climate-related and environmental risks¹¹ also showed that some banks have developed relevant policies and procedures to improve their alignment. Some of these were detailed in the ECB's report on good practices for climate-related and environmental risk management.¹² In addition, alignment assessments have also been applied by the ECB. As part of its thematic review, the ECB conducted case study interviews with banks, examining the files of banks' largest clients exposed to the elevated transition risks revealed in the alignment assessment. This allowed the ECB to assess the effectiveness of the banks' policies and procedures in practise. Supervisors examined how the banks identify, assess and mitigate these transition risks to gain insight into banks' ability to effectively integrate transition risks in their credit risk management. In this context, the ECB used counterparty-level alignment assessments which compared clients' trajectories with net-zero scenarios.

The Paris Agreement Capital Transition Assessment (PACTA) tool is the most commonly method used by banks to assess the alignment of corporations.

PACTA is an open-source tool that provides financial institutions with forward-looking science-based scenario analysis to inform their approach to portfolio alignment.¹³ PACTA compares the production pathways of corporations in climate-relevant sectors with scenarios that model what should happen in these sectors. PACTA relies on physical, asset-based corporation data to provide granular, regional, sector-specific and forward-looking production pathways. The tool can be used to assess financial institutions' alignment on an exposure-by-exposure basis, giving granular information on possible transition risks within their credit portfolio. The PACTA for Banks methodology¹⁴ can be used with various sources of external physical asset-based corporation data and was developed to match corporations' emissions with loan books in addition to equity and corporate bond portfolios. The PACTA tool is therefore used as the main building block for the alignment assessment applied in this report.

¹⁰ ECB, "The importance of being transparent: A review of climate-related and environmental risks disclosures practices and trends", April 2023.

¹¹ ECB, "Walking the talk: Banks gearing up to manage risks from climate change and environmental degradation", November 2022.

¹² ECB, "Good practices for climate-related and environmental risk management, observations from the 2022 thematic review", November 2022.

¹³ RMI, "PACTA – RMI".

¹⁴ 2° Investing Initiative, "PACTA for Banks Methodology Document", 2020.

3.1 Application of the approach

Further applications of alignment assessment are on the horizon, including in the context of voluntary industry initiatives, disclosure standards and regulatory transition planning requirements. In recent years several industry-led initiatives have been developed to enhance banks' climate-related and environmental risk disclosures, for which portfolio-level alignment assessments can be used as key inputs. For example, the recommendations set out by the Task Force on Climate-related Financial Disclosures (TCFD) require banks to disclose their main climate-related targets, such as emission reduction targets for their lending and other services.¹⁵ In addition, the Net Zero Banking Alliance (NZBA), which is the sector-specific alliance for banks under the Glasgow Financial Alliance for Net Zero (GFANZ), requires its members to disclose their progress against these targets for their absolute emissions and/or emissions intensity as evidence that they are delivering on their commitment to align their lending and investment portfolios with pathways towards net zero by 2050.¹⁶ These forward-looking measurements of portfolio alignment with the Paris Agreement can support banks' disclosures.¹⁷

The implementing technical standards (ITS) on Pillar 3 disclosures on ESG risks¹⁸ developed by the EBA are expected to increase the use of such disclosures by large banks with securities traded on a regulated market of any Member State and to make them more consistent and comparable. By mid-2024, in the ITS template 3 on alignment metrics, eligible banks must disclose the extent to which their lending and other services for different sectors are consistent with the IEA's Net Zero Emission (NZE) by 2050 scenario.

Moreover, with a view to ensuring that transition risks resulting from banks' misalignment with the Paris Agreement are effectively addressed, the proposal for a Directive amending the Capital Requirements Directive IV (CRD IV)¹⁹ requires banks' management boards to develop plans for the transition and supervisors to assess and monitor these plans. Requirements for the adoption and disclosure of plans are also included in the Corporate Sustainability Reporting Directive²⁰ and the proposal for a Directive on Corporate Sustainability Due Diligence.²¹ Based on the misalignment observed, these plans should indicate how banks intend to address the associated transition risks in the short, medium and long term in their business

¹⁵ TCFD, "[Metrics and Targets](#)", see in particular "For Banks".

¹⁶ United Nations Environment Programme Finance Initiative, "[The Commitment - Net-Zero Banking Alliance](#)".

¹⁷ The IFRS has not yet implemented the forward-looking alignment metric in the [Sustainability Disclosure Standard](#), as no single common practice on alignment assessment is used.

¹⁸ [Commission Implementing Regulation \(EU\) 2022/2453 of 30 November 2022 amending the implementing technical standards laid down in Implementing Regulation \(EU\) 2021/637 as regards the disclosure of environmental, social and governance risks](#).

¹⁹ [Proposal for a Directive of the European Parliament and of the Council amending Directive 2013/36/EU as regards supervisory powers, sanctions, third-country branches, and environmental, social and governance risks, and amending Directive 2014/59/EU](#).

²⁰ [Directive \(EU\) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation \(EU\) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting](#).

²¹ [Proposal for a Directive of the European Parliament and of the Council on Corporate Sustainability Due Diligence](#) and amending Directive (EU) 2019/1937.

models and strategies. As such, the plans should provide insight into banks' specific actions, like structured dialogues to support clients in their transition or phase-out of exposures to particular sectors (see Section 5).

3.2 Decarbonisation pathways

Forward-looking alignment assessments are conducted based on sectoral decarbonisation pathways. These pathways are in turn taken from long-term scenarios for the future. The Intergovernmental Panel on Climate Change (IPCC) describes scenarios as a plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (for example, the rate of technological change and prices) and relationships.²² Pathways are moreover described by the IPCC as a temporal evolution of a set of mitigation scenario features, such as greenhouse gas emissions and socioeconomic development, towards a future state that can include narratives of potential futures and solution-oriented decision-making processes to achieve desirable societal goals.

The sectoral decarbonisation pathways used in alignment assessments are normative or explorative in nature. Normative pathways set out narrow but achievable ways of ensuring the economy transitions towards achieving a specific temperature objective. The scenarios for the transition of the economy developed by the IEA and the European Commission's Joint Research Centre (JRC) are typically used in alignment assessments. These scenarios are based on integrated assessment models (IAMs) that bring together models of the economy, the energy system and, on a simplified basis, the climatic system. Such transition scenarios are representations of possible futures and cannot be interpreted as providing forecasts or predictions as such. They can be further broken down into two types of scenarios:

- **Exploratory scenarios** which look at the potential effect of policies and pledges. Modelling for the scenarios is predicated on what may happen if current stated policies as well as longer-term policy pledges and commitments are implemented. They include the following scenarios:
 - IEA World Energy Outlook 2022: the Stated Policies Scenario (STEPS) and Announced Pledges Scenario (APS).
 - JRC GECO 2022: the "Reference scenario" and the "Nationally Determined Contributions and Long-Term Strategies (NDC-LTS) scenario".
- **Normative scenarios** that backcast achievement of a 1.5°C climate change stabilisation goal. These scenarios are backcast pathways to stabilising the global mean rise in temperature at 1.5°C by 2100. Modelling is based on combinations of assumptions that have been tested and selected in order to achieve the specific climate outcome. Intermediate objectives also include the

²² See the glossary in IPCC, "[Special Report: Global Warming of 1.5°C](#)", 2018.

minimisation of temperature overshoot in 2050 and the achievement of net-zero emissions by 2050. Both the IEA and the JRC have developed a normative 1.5°C scenario, with the ambitious modelling choices and assumptions bounded by, amongst other considerations, what can be judged to be technically feasible, economically efficient and socially acceptable:

- IEA WEO 2022: the “Net Zero Emissions by 2050 scenario”.
- JRC GECO 2022: the “1.5°C scenario”.

Such scenarios take on central importance in the context of climate action by the European Union. The European Climate Law²³ sets out a binding objective for the Union to reach climate neutrality by 2050 in pursuit of the long-term temperature goal set out in the Paris Agreement²⁴ and a 2030 target of at least a 55% reduction in net emissions of greenhouse gases compared to 1990. The Law rests on the scientific findings of the IPCC, particularly the need to urgently reduce greenhouse gas emissions and to limit climate change to 1.5°C (Recital 3). Moreover, EU and national measures to achieve the climate neutrality objective are anchored, in particular, in the findings reported by the IPCC (Recital 34).

3.3 Selection of the decarbonisation pathway

This report applies the IEA’s NZE 2050 as the decarbonisation pathway scenario, as it is broadly consistent with the European Climate Law. There are many possible pathways that can be chosen for assessing alignment. The choice of pathway has important consequences, as decarbonisation pathway scenarios can differ significantly. The Guide on good practices for climate-related and environmental risk management published together with the outcome of the 2022 thematic review can be used to select a decarbonisation pathway scenario. This Guide collects the best practices observed among financial institutions in the area of climate-related and environmental risk. Based on these best practices, the following five aspects are identified as key to the process of selecting a decarbonisation pathway.

1. The scenario should be science-based and originate from reputable sources

The IEA is an intergovernmental organisation that focuses on the global energy system. Its flagship publication is the World Energy Outlook on the state of the global energy system. Its NZE 2050 decarbonisation pathway was published as part of the outlook on the future state of the energy system.

2. The temperature target should be consistent with stated (policy) objectives

The Paris Agreement provides that global warming is halted at well below 2°C

²³ Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 (‘European Climate Law’) (OJ L 243, 9.7.2021, p. 1).

²⁴ United Nations, [Paris Agreement](#), 2015.

above pre-industrial levels, and that efforts are made to limit global warming to 1.5°C. Under the IEA NZE 2050 decarbonisation pathway, there is a 50% chance that the temperature rise would be limited to 1.5°C by 2050.²⁵ As such, it is consistent with EU policy objectives.

3. The scenario should be geographically relevant to the portfolio under investigation

Financial institutions within the euro area extend credit to corporations operating across the world. Just over half of the assets of the corporations to which they extend credit are outside the EU. For analytical purposes, the scenario should thus be global in scope, making the IEA NZE 2050 decarbonisation pathway a suitable option. Going forward, further geographical differentiation could be applied for counterparties operating in specific jurisdictions only.

4. The scenario should be up to date, and the choice of base year should be well justified

This report uses data from 2022. The IEA NZE 2050 was originally published in 2021, but was updated in 2022 to take subsequent changes into account. The base year of the decarbonisation pathway thus lines up with the year of analysis.

5. Scenario choices used for strategic planning, risk management and disclosures should be internally consistent and well documented

For the purposes of consistency, this report is based on the same scenario as used for the counterparty-level alignment assessment conducted as part of the thematic review. This report analysis the banking sector rather than a specific bank, the application to strategic planning and risk management therefore does not apply.

It is worth noting that these criteria are broadly consistent with guidance set forth by, for example, GFANZ,²⁶ which recommends that scenarios need to be granular, actionable, credible and dynamic. It is particularly important that these scenarios are updated on an annual basis to take into account world events, the evolution of the carbon budget and technological developments.

In the NZE 2050 decarbonisation pathway developed by the IEA, net carbon emissions decrease towards zero in 2050, leading to a 50% probability that global temperatures will be at or below 1.5°C in 2050. This is in line with the temperature rise of well below 2.0°C and preferably limited to 1.5°C in 2050 agreed in the Paris Agreement. The IEA NZE 2050 decarbonisation pathway achieves this by reducing CO₂ intensity over time (see Chart 3.1).

²⁵ A limited overshoot of 0.1°C is still possible under the scenario, but by 2100 temperature should again be below 1.5°C.

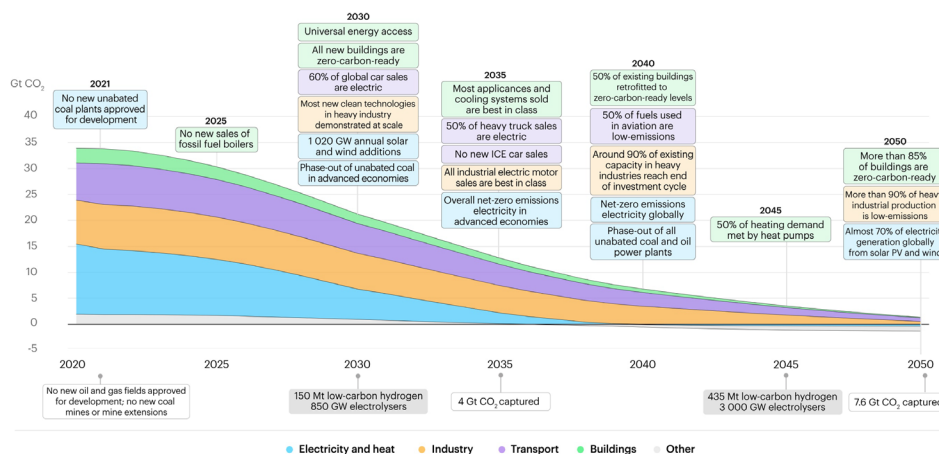
²⁶ Glasgow Finance Alliance for Net Zero, "[Guidance on the use of sectoral pathways for financial institutions](#)", June 2022.

Chart 3.1

Carbon emission reduction under the IEA NZE 2050 decarbonisation pathway

Some of the required policy changes are listed for years by which they should be completed

(Gt CO₂ per annum)



Source: IEA, "Net Zero by 2050: a Roadmap for the Global Energy Sector", May 2021.

Note: Net zero is achieved by also removing about 7.8 Gt CO₂ from the atmosphere per year in 2050.

Chart 3.1 shows specific policies that should lead to net-zero carbon emissions by 2050. For example, under the IEA NZE 2050 decarbonisation pathway, cars with internal combustion engines will no longer be sold from 2035 and coal power plants should be phased out in advanced economies by 2030. Corporations should adjust to these kinds of policy changes. For advanced economies, such as the EU, the emissions reductions pledged and announced are close to those anticipated in the IEA NZE 2050 decarbonisation pathway.²⁷ For instance, the EU prohibits the sale of new fossil fuel-powered passenger cars by 2035,²⁸ requires all new buildings to be zero emission from 2030²⁹ and limits industry emissions in 2030 to about 70% of the 2020 level.³⁰ All of these policies are in line with the IEA NZE 2050 decarbonisation pathway. Corporations will have to shift their production significantly to achieve these targets. Table 3.1 gives an overview of the required shift in production capacities. As the shift in production is enforced, corporations that have not already started to adjust to the new policies will need to invest to quickly change their production capacity or risk losing significant market share. Table 3.1 shows the changes needed under the IEA NZE 2050 decarbonisation pathway and the required scale of the shift in production. A more detailed description of the decarbonisation pathway can be found in Annex 3.

²⁷ IEA, "World Energy Outlook 2022", p. 72.

²⁸ Regulation (EU) 2023/851 of the European Parliament and of the Council of 19 April 2023 amending Regulation (EU) 2019/631 as regards strengthening the CO₂ emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition (PE/66/2022/REV/1), (OJ L 110, 25.4.2023, p. 5).

²⁹ Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings (COM/2021/802 final).

³⁰ Under the emission trading system the industry emission will be reduced by around 30% in 2030 compared with Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a system for greenhouse gas emission allowance trading within the Union and amending Council Directive 96/61/EC.

Table 3.1

Production changes required worldwide under the IEA NZE 2050 decarbonisation pathway

A closer look at the changes required in the power, oil and automotive sectors

	2010	2020	2030	2040	2050
Solar PV and wind energy installed capacity (gigawatts)	238	1,474	8,057	17,505	22,723
Number of electric vehicles produced (minimum per year)	-	3	59	142	166
Oil extraction (minimum number of barrels per year)	26,666	28,277	22,393	12,913	6,865

Source: IEA.

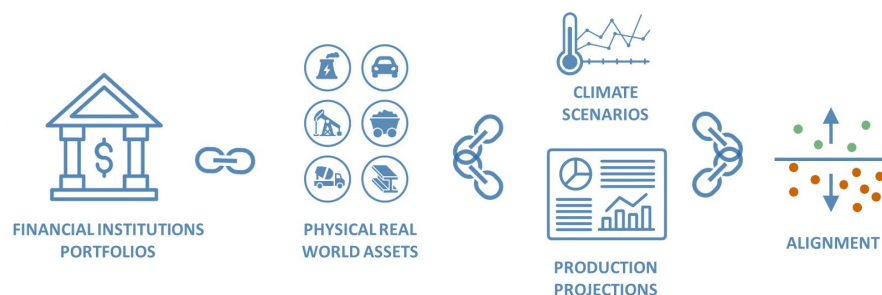
3.4 Overview of the methodology

The assessment of alignment is based on forward-looking production data for assets within the sectors most impacted by the shift towards a low-carbon economy. The methodology used in the alignment assessment is based on the PACTA for Banks Methodology,³¹ which focuses on the alignment of credit portfolios with decarbonisation pathways in six key sectors. This involves combining data on credit portfolios with forward-looking production asset data and decarbonisation pathway data to assess the degree of alignment of a specific credit portfolio. The result can be subsequently used to quantify and better understand the transition risks an institution is facing. Section 4.1 provides more detail on the data sources used and describes the alignment assessment methodology and how the net alignment rate is determined.

Chart 3.2

Overview of the alignment assessment methodology

The credit portfolio of a financial institution is linked to real-world assets. The projected changes in these real-world assets are compared to the changes required under the selected decarbonisation pathway. Alignment is calculated based on the difference between these two factors.



Sources: RMI and ECB.

³¹ See RMI, "PACTA for Banks Methodology Document: Climate scenario analysis for corporate lending portfolios", July 2022.

3.4.1 Data sources

The alignment assessment uses data from AnaCredit for the loan portfolios of financial institutions and from the physical assets matched with securities (PAMS) dataset of Asset Impact. The AnaCredit data cover credit extended by euro area banks and their euro area subsidiaries. The PAMS Asset Impacts dataset is a forward-looking database of physical assets in key CO₂-intensive sectors. A short description of the two datasets is given below:

- (i) **AnaCredit** contains detailed information on the individual loans issued by banks and their subsidiaries in the euro area. The credit within the AnaCredit database consists of all the credit above €25,000 to non-natural persons. In December 2022 the AnaCredit database consisted of over 12,800,000 credits with a total outstanding value of around €4,850 billion extended to non-financial corporations, including around 3,600,000 unique counterparties. Only a small proportion (around 4%) of total exposures are considered for the purposes of this report, which is limited to credit to the six key transition sectors only. AnaCredit only holds data on the credit supplied by euro area banks and their euro area subsidiaries. Credit supplied by subsidiaries outside of the euro area are thus not taken into account.
- (ii) The **PAMS** dataset contains data on the production capacities of assets in the eight sectors (cement, coal, oil and gas, power generation, steel, automotive, aviation and shipping)³² that are responsible for over 70% of global CO₂ emissions. The assets within the PAMS database are linked to the subsidiary that directly controls the asset and to the parent corporation based on equity ownership in a pro rata manner. This allows for the allocation of the physical assets to a parent corporation, as credit is often extended at the parent level. For all assets in the dataset, the production capacity is projected for the years 2022-2027. This data is constructed by looking at the concrete plans, as opposed to the ambitions, of corporations to change their production capacities in the coming years. Information on such plans is derived from public disclosures or direct engagement with corporations. It is only included if the plans are sufficiently concrete for the corporation to change its production capacity within five years. Examining these concrete plans for production capacities decreases the chance that the data do not accurately capture what is happening.

The counterparties from AnaCredit need to be linked to the corporations in the PAMS dataset. This is done by matching their Legal Entity Identifier (LEI) codes, or where these are not available, matching them by name. As the AnaCredit dataset has a higher level of granularity, the AnaCredit data can also be matched at the intermediate and ultimate parent level if no direct match is found in the PAMS

³² The shipping and aviation sectors are not yet taken into account in the PACTA analysis.

dataset. This overall matching performs well when looking at the amount of assets covered in the euro area, where over 70% of the assets are owned by the counterparties to which euro area banks extend credit. This indicates that the majority of credit supplied to these key transition sectors has been correctly identified and matched to the PAMS dataset, as it is to be expected that most euro area assets are owned by corporations that receive financing from euro area banks (see Annex 1 for more detail on the results of the matching exercise). For corporations present in multiple sectors, the loan amount needs to be allocated over the sectors, as the alignment assessment is applied at sector level. This allocation is done pro rata based on the share of production in a sector with respect to worldwide production. In 80% of the cases the primary sector of a corporation is more than 50 times larger than all the other sectors a corporation is active in combined.

3.4.2 Paris Agreement Capital Transition Assessment methodology

The alignment assessment method used in this report is based on the open-source Paris Agreement Capital Transition Assessment (PACTA) methodology. The PACTA methodology compares the required changes by corporations within the credit portfolio of a bank to the projected changes of those corporations. For each corporation within a credit portfolio, alignment is determined on a technology-by-technology or an emission intensity basis. Alignment refers to the difference between projected production and the production according to the decarbonisation pathway relative to the initial production.³³ Each corporation is subsequently aggregated and weighted according to the amount of credit extended to it (see Annex 2 for more details on the methodology).

The PACTA methodology measures the deployment of fifteen different technologies in six key transition sectors. The PACTA methodology focuses on specific segments of the supply chain at which alignment is determined, taking into account the decarbonisation pathway. These segments can be seen as important levers in the overall supply chain. For example, in the coal sector, the main transformation needs to take place in the mining of coal. Conversely, transformation in the manufacturing of machinery for mining would have a much smaller impact, as other resources will still need to be mined and the demand for machinery will continue to exist. The PACTA methodology covers three distinct types of technology within these sectors: phase-out, build-out and decarbonisation technologies. Phase-out technologies are present in the oil and gas, coal, automotive and power sectors. These technologies will have to be (partially) phased out in the coming decades, depending on the decarbonisation pathway. Build-out technologies are present in the automotive and power sectors and will have to be built out, as they represent a zero-emission alternative to the technologies that should be phased out. Decarbonisation technologies need to undergo transformation from high-carbon intensity towards low-carbon intensity. However, as no alternative technologies are available, making a clear transformation from one technology to another is unlikely. Decarbonisation

³³ For build-out technologies, the initial sector production is used rather than the initial technology production.

technologies should therefore decrease their carbon intensity over time. This holds for the cement and steel sectors. In calculating build-out and phase-out alignment, certain technologies are treated differently, as they face additional obstacles to implementation in certain jurisdictions.³⁴

The PACTA methodology has a forward-looking horizon of five years, as it takes into account corporates' production plans. The PAMS dataset includes the plans of the corporations for the next five years. For plans to be included in this five-year projection, the following criteria need to be met: (1) an asset is assigned a start year; (2) an asset is under actual development or under construction; and (3) asset capacity or planned production has been publicly announced. These criteria ensure that only data on assets that have a reasonable expectation of changing are collected. This prevents corporations from engaging in greenwashing, for example by announcing unverifiable plans for “green” production facilities. This five-year forward-looking horizon gives a good idea of how much a corporation is transitioning towards a decarbonised economy, as plans to build new production capacity can often take several years to complete. Of the companies in the PAMS dataset, 18% have projected a change in production. This is mainly caused by the presence of many power producers with very small production assets. For the automotive, coal, and oil and gas sectors, the percentage of companies projecting changes in production rises to 99.1%. Of the loans matched with AnaCredit, 98.7% of the credit weighted by outstanding amount is subject to a projected change in production.

Alignment is measured by comparing the rate of change in technology deployment with the rate of change required under the decarbonisation pathway. The difference between the projected change in production and the decarbonisation pathway target gives rise to the deviation. For instance, this can be the amount of renewable energy that has to be produced in a certain year to adhere to the decarbonisation pathway minus the actual production of renewable energy in megawatts. To get to alignment from this deviation, the deviation is divided by the initial production in the sector.³⁵ This makes it possible to compare corporations with different production volumes and different technologies. Chart 3.3 illustrates how deviation is calculated for build-out and phase-out technologies. For decarbonisation technologies, a slightly different methodology is applied (for more detail, see Annex 2 and the PACTA Methodology Document).³⁶

³⁴ This is the case for hydropower, as additional hydropower is limited in many regions. To conclude that corporations are not doing enough to build out their capacity while there are no sites available for the expansion of hydropower in the regions they are active in does not seem appropriate. For nuclear power, this can also hold owing to strong opposition in certain jurisdictions. The net alignment rate of these corporations are not affected by this and they will be misaligned if they fail to build out enough net zero energy sources.

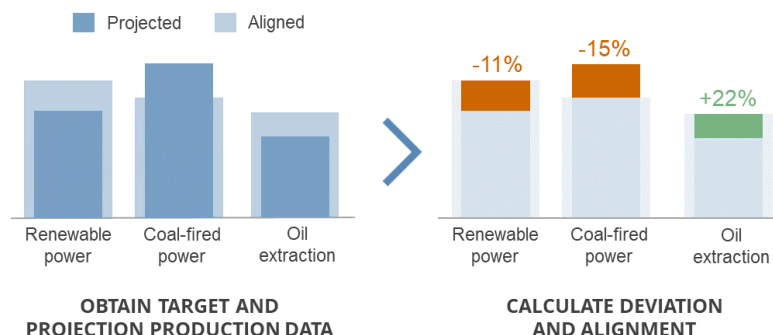
³⁵ For phase-out technologies, the production of the technology is employed rather than that of the sector.

³⁶ See RMI, “[PACTA for Banks Methodology Document: Climate scenario analysis for corporate lending portfolios](#)”, September 2020, pp. 50-55.

Chart 3.3

Calculation of alignment for phase-out and build-out technologies

Calculation of alignment for a build-out technology (renewable energy) and two phase-out technologies



Source: ECB.

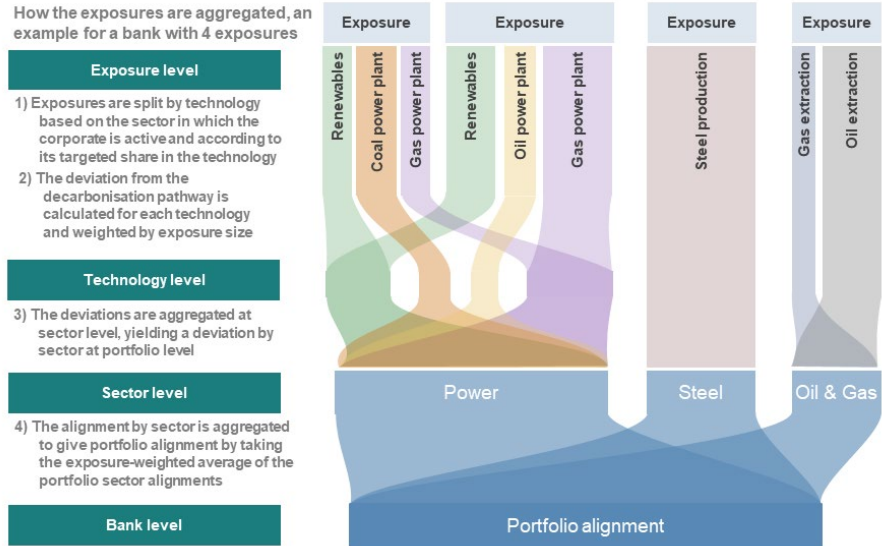
Notes: "Aligned" refers to the production target set under the decarbonisation pathway. The alignment is calculated as the percentage deviation between the production target of a certain corporation and the projection of the corporation divided by the initial production. If a technology needs to be built out, a projection higher than the target results in positive alignment; if the technology needs to be phased out, a projection higher than the target results in negative alignment. For low-carbon technologies, the initial sector production is used, as initial production volumes can be small.

3.4.3 Determination of net alignment rates

To assess and benchmark alignment at bank level, the technology-level (mis)alignments from PACTA are aggregated to give a net alignment rate for each bank. The results from the PACTA analysis are at the technology level. They therefore need to be aggregated to allow for comparison of the alignment of different banks, as banks might be active in different technologies and different sectors, and to different extents. To generate a single alignment metric for a portfolio, the results of the different technologies first need to be aggregated. This aggregation takes place at sector level. For sectors with multiple technologies, an exposure-weighted sum of the deviation in build-out technologies and the deviation in phase-out technologies is calculated. This total deviation is divided by the total initial production in the sector to get a relative measure of alignment at sector level. This net alignment at sector level can be aggregated to give the portfolio-level alignment by taking the exposure-weighted average of the sector results. The net alignment results thus weigh all six sectors equally, as the level of risk incurred by the holder of the exposure is not dependent on the sector size, but on the exposed amount. This net alignment rate is an indicator of the overall risk to a financial institution stemming from the transition towards a decarbonised economy (see Chart 3.4 for an overview of this process).

Chart 3.4

Aggregation from the individual exposures to the net alignment of the bank



Source: ECB.

Notes: The exposures represent a bank's portfolio. The width of the block indicates the size of an exposure. For power sector exposures, for the sake of simplicity, the hydro and nuclear power contributions are not shown.

Box 1

Getting to net alignment

This box recreates net alignment for an institution with three loans in different sectors in order to clarify how net alignment works and aid interpretation of the output.

Table B.1

Overview of production capacities of corporates financed by euro area banks

Loan ID	Corporation ID	Sector	Technology	Exposure	Initial production	Projected production	Target production	Direction	Deviation	Sectoral deviation	Alignment
1	3160	Oil and gas	Oil	€1,900,000	824,230 barrels	812,090 barrels	723,381 barrels	phase-out	-88,709	-11%	-11%
2	3426	Power	Renewables	€342,956	200 MW	240 MW	584 MW	build-out	-344	-25%	-12%
2	3426	Power	Coal power	€342,956	1,200 MW	800 MW	982 MW	phase-out	182	15%	-12%
3	6004	Coal	-	€2,708,000	42,700 tonnes	22,700 tonnes	30,649 tonnes	phase-out	7,351	17%	17%

Notes: An example of the data for three loans combined with the AI data

Sources: AI, RMI, ECB calculations.

Alignment at the technology level refers to the additional change in production capacity that would be required for production to align with the decarbonisation pathway divided by the corporate's initial technology production (for build-out technology the change in production capacity is divided by the corporate's initial sectoral production rather than the initial technology production). Taking Loan 3 in Table B.1 as an example, it can be seen that the corporate phased out 17% more of its coal production than required. To calculate the net alignments from these loans, the net alignment in the power sector has to be determined by adding the deviations. So the total deviation in the power sector, taking into account whether technologies are built out or phased out, is -162 and the resulting alignment is -12%. Based on the exposure-weighted average of the alignments, the total net alignment is 4%. In this hypothetical example, this results from the relatively large, well aligned exposure to the coal sector. On average the corporates in this portfolio are thus transitioning 4 percentage points faster towards net zero than the decarbonisation pathway require.

Sources: RMI and ECB.

3.5 Scope of analysis

The current analysis focusses a comparatively small number if sectors in which the bulk of emission reductions need to take place and transition risks are most pronounced. The scope of the analysis for credit portfolio alignments has been discussed in the previous sections. The credit portfolios are limited to the euro area bank and their euro area subsidiaries. Also, only six transition sectors are taken into account, limiting the analysis to corporate loans. Additionally in this report the IEA NZE 2050 decarbonisation pathway is the only decarbonisation pathway analysed. The main limitation of the alignment assessment is the small number of sectors taken into account, even though they cover over 70% of total CO2 emissions (see Chart 3.5 for an overview of the scope of the alignment assessment conducted in this report).

Chart 3.5
Overview of the scope of analysis

Indications of where the assessment methodology can be expanded

	Scope	Pathways	Sectors	Horizon	Credit risk	Market risk	Operational risk
Transition risk	Euro area (Anacredit scope)	IEA NZE 2050	Key sectors	1-5 years (2022-2027) based on trendline to 2030 scenario milestones	Corporate loans (including SMEs)	Securities	Reputation and liability risk through consistency of strategy with bank commitments
	Rest of the world (targeted data request)	IEA announced pledges	- Shipping - Aviation - Real estate		Household loans (including mortgages)	NFC-issued Covered bonds	

Source: ECB.
Notes: Exposures from outside the euro area can be incorporated in future vintages of the analysis, through a targeted data request.

This approach to alignment assessment can be further developed to cover a wider range of transition risks faced by banks. The current approach does not encompass all transition risk faced by banks. It focuses on assessing the credit extended by euro area banks and subsidiaries to key transition sectors. However,

the approach can be extended to cover a larger part of the transition risks faced by banks. Banks have significant exposures to counterparties in key transition sectors based in jurisdictions that fall outside of the scope of the AnaCredit dataset, but which have an impact on the risk profile of the institution. The alignment of an exposure can only be assessed if the exposure can be identified in the AnaCredit dataset and linked to the PAMS dataset. The PAMS dataset has worldwide coverage, but AnaCredit is limited to euro area banks and their euro area subsidiaries. If the AnaCredit data could be extended to include the worldwide subsidiaries of euro area banks, the worldwide exposures of the banking groups could be taken into account. This would generate a more complete understanding of the transition risks in the credit portfolios. Targeted additional reporting of the banking groups with non-euro area subsidiaries could expand this analysis to a global level. The alignment assessment currently comprises six sectors. While this covers most of the CO₂ emissions, there may be significant transition risks outside of these six sectors. The PACTA analysis could be further extended to cover the shipping and aviation sectors, which would expand the assets covered by a potential €64 billion. The real estate sector could also be included. From a methodological point of view, more work needs to be done to agree upon a method for determining alignment for these types of assets. If alignment assessment is extended to include real estate, it would also make sense to not only cover exposures to corporates, but household exposures in the form of mortgages as well. This would greatly increase the coverage of credit risk through alignment assessment. Market risks stemming from banks' securities portfolios could also be included in a future assessment.

Box 2

How alignment could work for real estate

The real estate sector constitutes a significant portion of financial institutions' exposure, accounting for over €5,000 billion across the euro area banking system.³⁷ For the residential real estate sector, which accounts for more than 90% of the European Union's building stock, transition will primarily focus on renovations to improve buildings' energy efficiency. However, financial institutions cannot yet fully gauge the energy performance of their real estate exposure, and most households are also unaware of the energy performance of their homes.

Where possible, building energy performance is tracked using Energy Performance Certificates (EPCs). These certificates include an energy efficiency rating and recommendations for cost-effective improvements. The EPC has already been shown to impact a property's value,³⁸ and mortgages associated with energy-inefficient houses are more vulnerable to higher energy prices and shocks to housing markets. Encouraging mortgage holders to enhance the energy performance of their buildings could be a strategic move for financial institutions, helping to reduce loss given default and decrease market risk associated with collateral.

The real estate banks' portfolio alignment can be calculated using the portfolios' average EPC rating and the expected change in the EPC rating. Information on building performance needs to be standardised and, crucially, property asset improvements need to be tracked in order to have

³⁷ Based on FINREP reporting for the fourth quarter of 2022.

³⁸ See "[Impact of the EPC on the property value](#)", Concerted Action EPBD, June 2019.

adequate data for the euro area. This could potentially be linked to key points of intervention in property transactions, where banks, in collaboration with other stakeholders, can influence the decision-making of both retail and commercial clients. Recently developed asset-level analytical tools have the potential to automate alignment measurement for large property portfolios and create projections for cost-effective, forward-looking renovation pathways. For example, some banks use the CRREM tool to determine when a building's energy performance falls below the level required for a decarbonisation pathway.

Sources: RMI and ECB.

Transition risks are not only present in the six key sectors analysed in this report. For instance, the bank with the highest relative exposure is also among the most misaligned, highlighting the presence of substantial risks for this institution. Transition risks are not only present in the six key sectors analysed within this report. In other sectors, the production of corporations might also differ significantly in a decarbonised economy. For corporations that have to adjust their production in other sectors there could also be climate transition risks. For instance, suppliers to the six key transition sectors and their end-users can also face a significant level of transition risk. A manufacturer of gearboxes for traditional vehicles may face a significant decline in business given a transition to electric vehicles, which no longer require traditional gearboxes. The amount of exposure to corporations active in the NACE sector: *Manufacture of other parts and accessories for motor vehicles*, for example, is already more than three times that in the *Manufacture of motor vehicles* sector. However, it is more challenging to assess the extent to which these corporations should adapt their production, as some, for example seatbelt producers, may be less impacted than others, such as drivebelt producers.

The euro area banking sector provides significant lending to physical production infrastructure critical to the transition towards a decarbonised economy. At the end of 2022 euro area banks financed €3,650 billion in credit to non-financial corporations in AnaCredit. Only a minority of these exposures are in the key transition sectors. Of the total credit of €3,650 billion, €189 billion in credit was extended to counterparties with assets in the oil and gas, coal, power generation, automotive, steel, and cement sectors. Although these key transition sectors only account for just over 5% of total non-financial corporate exposures, they still cover roughly half of the total CO₂ emissions in the euro area.³⁹ As forward-looking data collection develops, other sectors can be added to the alignment assessment, such as shipping and aviation, which should lead to a significant increase in the percentage of non-financial corporate exposures covered.

It is worth noting that the maximum exposure between a bank and a single counterparty exceeds €5 billion. The largest volume of financing flows into the power sector (see Table 3.2). There are also significant exposures in the automotive, oil and gas, and steel sectors, which collectively account for the majority of production in the euro area. While exposures to the cement and coal sectors are relatively

³⁹ This is estimated based on the share of euro area assets that are financed by euro area banks and the total share in total CO₂ emissions of the key transition sectors.

smaller, they still play a substantial role in the euro area's overall production capacity.

Table 3.2

Overview of production capacities of corporates financed by euro area banks

Sector	Exposures (EUR billions)	Financed production capacity in the euro area (absolute)	Financed production (share of euro area total)
Oil and gas	25.2	192,000,000 barrels	60%
Coal mining	6.9	68,300,000 tonnes	49%
Power generation	113	444,000 megawatts	64%
Automotive	28.5	10,900,000 vehicles	87%
Steel	13.2	80,800,000 tonnes	76%
Cement	2.32	60,800,000 tonnes	35%

Sources: IEA, AI, RMI and ECB calculations.

Notes: Outstanding exposures are based on AnaCredit data for the fourth quarter of 2022. The share of production is based on AI data. For financed production, the euro area assets are taken and only those assets included which could be linked to a counterparty in the AnaCredit dataset (either based on a direct match or on a parent entity match), regardless of the amount of financing.

4 Alignment of euro area banks

This chapter explores in more detail the results of the alignment assessment of the credit portfolios of euro area banks. The alignment assessment was conducted for the credit portfolios of euro area banks as at December 2022 using the methodology set out in Section 3.4 and taking into account the six key transition sectors. Banks with no exposures in these sectors were not analysed, leading to a sample of 95 significant institutions. The results are aggregated at various levels, which shows the versatility of alignment assessment as a tool. First, alignment is analysed at system level, before being assessed at bank level. Next, alignment within specific sectors is explored, followed by alignment at the individual corporation level. This gives an overview of the potential results that can be gained from performing alignment assessment and shows how transition risks can be further identified and quantified.

4.1 System-level results

The need for a significant transformation in euro area production in order for it to align with the European Climate Law is clear, especially in the key transition sectors, which are not changing as quickly as required. Euro area banks, as major contributors to the financing of these sectors, face similar challenges. Table 4.1 provides an overview of projected production compared to the required production under the global decarbonisation pathway outlined in the IEA NZE 2050 decarbonisation pathway, for both the euro area as a whole and euro area banks.

Table 4.1

Overview of required and projected production changes by euro area corporates and corporates financed by euro area banks

Sector	Euro area required change in 2027 (absolute)	Euro area projected change in 2027 (absolute)	Financed production required change in 2027 (absolute)	Financed production projected change in 2027 (absolute)
Oil and gas	- 38,600,000 barrels	- 132,000,000 barrels (342%)	- 23,300,000 barrels	- 84,500,000 barrels (363%)
Coal mining	- 39,300,000 tonnes	- 15,500,000 tonnes (39%)	- 19,300,000 tonnes	- 6,560,000 tonnes (34%)
Power generation	+ 307,000 MW renewable - 26,200 MW fossil	+ 72,500 MW renewable (24%) - 5,300 MW fossil (20%)	+ 197,000 MW renewable - 18,800 MW fossil	+ 28,200 MW renewable (14%) - 11,400 MW fossil (61%)
Automotive	+ 4,030,000 electric vehicles - 3,370,000 conventional vehicles	+ 6,180,000 electric vehicles (153%) - 2,360,000 conventional vehicles (70%)	+ 3,520,000 electric vehicles - 2,940,000 conventional vehicles	+ 5,220,000 electric vehicles (148%) - 2,020,000 conventional vehicles (69%)

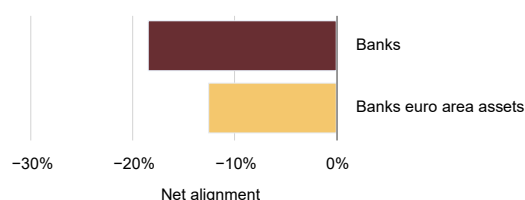
Sources: IEA, AI, RMI and ECB calculations.

Notes: The figures show the required change and the projected change in the aggregates of all production capacities of all euro area counterparties and of all counterparties financed by euro area banks, within the scope of the analysis. Hybrid vehicles are included in the electric vehicle count.

The reduction in oil and gas production within the euro area is occurring at a much faster rate than that mandated by the decarbonisation pathway. In fact, oil production in the EU peaked in 2004 and has since been steadily declining.⁴⁰ Some euro area members are actively discouraging the development of new sources of oil and gas.⁴¹ However, the coal industry is not reducing production quickly enough to align with the decarbonisation pathway. Similarly, the power sector is lagging behind, achieving only 20-25% of the target set for decarbonisation within the euro area.⁴² Euro area banks are more frequently extending credit to corporations that are phasing out fossil fuel power plants within the euro area than to those that are not. But the transition to renewable energy sources is not adequately represented in their credit portfolio. With regard to the automotive sector, the shift towards electric cars appears to be progressing at a satisfactory pace, driven in part by EU regulations mandating the sale of zero-emission vehicles only from 2035.⁴³ The industry appears to have plans in place to meet this requirement. Nevertheless, the decline in internal combustion engine vehicles is happening at a slower rate than required under the decarbonisation pathway, which could lead to potential overproduction of internal combustion vehicles within the euro area. This could give rise to stranded assets for the corporations owning the production infrastructure for such vehicles, meaning that the corporation may have to take losses on such assets, and that those assets would lose value as collateral.

Chart 4.1

Net alignment of the euro area assets of euro area banks and of euro area banks as a whole



Sources: IEA, AI, RMI, Eurostat and ECB calculations.

Notes: If the net alignment is above 0, the adjustments are going faster than the decarbonisation pathway; if the net alignment is below 0, the changes are lagging behind the decarbonisation pathway. The net alignment is computed using the IEA NZE 2050 decarbonisation pathway for the oil and gas, coal mining, power generation, automotive, steel, and cement sectors.

The portfolios held by euro area banks in the six key transition sectors show significant misalignment, while the euro area located assets of the portfolios in these sectors are better aligned. This trend is clearly illustrated in Chart 4.1, which shows the net alignment for both euro area banks and the euro area located assets of euro area banks. When non-euro area production facilities are also included in the analysis, the net alignment of banks' portfolios becomes even more negative. One

⁴⁰ See Eurostat web page on "[Oil and petroleum products – a statistical review](#)", 15 March 2023.

⁴¹ France, Denmark and Portugal, among others, have already joined the [Beyond Oil and GAlliance](#) and taken steps to solidify this in their local laws for example.

⁴² For decarbonisation, renewables play the most significant role, although an increase in nuclear is also foreseen in the decarbonisation pathway, albeit this target is also not being achieved.

⁴³ [Proposal for a Regulation of the European Parliament and of the Council amending Regulation \(EU\) 2019/631 as regards strengthening the CO2 emission performance standards for new passenger cars and new light commercial vehicles in line with the Union's increased climate ambition \(COM/2021/556 final\).](#)

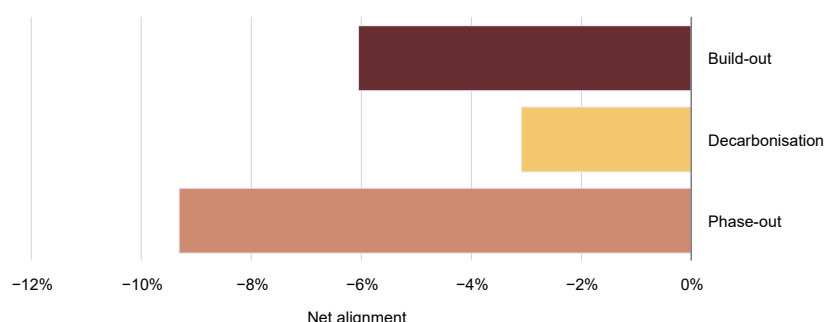
reason for this net misalignment originates in the weighting based on the exposure values of the euro area banks towards the corporations holding these assets. In other words, the banks in the euro area are providing more funding to misaligned corporations than to aligned ones. This also shows in the data, which show the average exposure to a misaligned corporation to be 30% higher than the average exposure to an aligned corporation. This indicates that the financing of more aligned corporations is lagging behind the financing of misaligned corporations.

In the IEA NZE 2050 decarbonisation pathway, the euro area banking sector exhibits significant misalignment and, as a result, heightened transition risks.

The primary source of the misalignment uncovered by this analysis can be traced back to the financing of corporations that are not making sufficient efforts to phase out carbon-intensive technologies (see Chart 4.2). The current lack of both build-out of net-zero technologies and phase-out of carbon intensive technologies increases the chance of a disorderly transition, as shifts will have to occur faster, increasing the transition risks for banks. This leads to an increased likelihood of a stronger policy response or of new competitors taking over the market. Ignoring these transition risks, leads to a higher risk of default for certain corporations and, in turn, larger than expected losses for the banks that finance them.

Chart 4.2

Net alignment of euro area banks: breakdown by build-out, decarbonisation and phase-out technologies



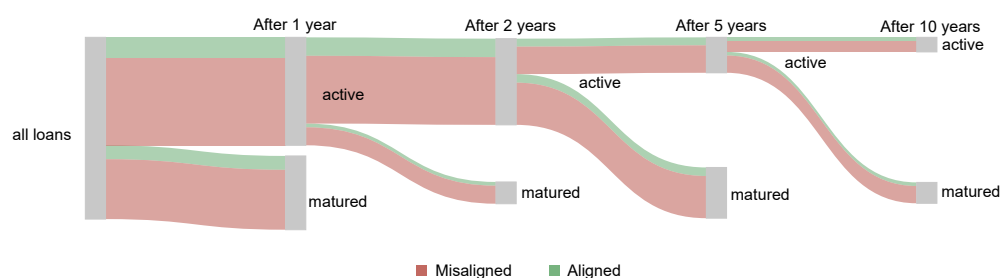
Sources: IEA, AI, RMI, Eurostat and ECB calculations.

Notes: The net alignment is computed using the IEA NZE 2050 decarbonisation pathway. The analysis is based on euro area banks' credit portfolios as at December 2022.

The majority of loans extended to key transition sectors are set to mature within two years, while their original maturity was seven years. Based on AnaCredit reporting, approximately 40% of the credit analysed in this study will reach maturity within the first year. Of the credit maturing in the first year, 19% is aligned, while credit with a longer maturity has a 22% alignment rate (see Chart 4.3). Over the subsequent four years, credit reaching maturity continues to be few percentage points less aligned than the credit that remains active. Within a five-year timeframe, 80% of the credit will have matured, and this figure increases to 92% within a ten-year period. This provides banks with an opportunity to evaluate and address alignment concerns when considering credit rollover, a topic further explored in Chapter 5. The increased transition risks are already present. If corporations are currently not making enough plans to shift their production into line with the Paris

Agreement, external events (for instance additional environmental regulation, rises in the CO2 price or climate litigation) could reduce their credit rating or the value of their assets used as collateral, in particular if the transition becomes disorderly and thus more abrupt government intervention more likely.

Chart 4.3
Credit maturities for the banks analysed



Sources: IEA, AI, RMI and ECB calculations.

Notes: For the purposes of this chart, it is assumed that all loans end when they mature and that no loans will be rolled over. The size of the flow between the nodes shows the exposure volume.

Although most of the credit is due to mature in the next five years, it is worth noting that the average original maturity period was approximately seven years, indicating that banks typically extend credit to corporations in these sectors over longer durations. Additionally, loan rollover is common, as bank-client relationships tend to endure far beyond individual contracts.

4.2 Bank-by-bank results

The net alignment rate of a bank's portfolio provides an aggregated perspective on the deviation of its financed production capacity from the decarbonisation pathway and in turn on the transition risks present within its credit portfolio. Section 4.2 presents the net alignment rates of banks' portfolios, weighted by exposure size. That is, the (mis)alignment of each counterparty is determined as a percentage deviation from the decarbonisation pathway by technology, and these individual percentage deviations are then aggregated by weighting them by the outstanding nominal exposure amount. This shows how well the bank's loan book in the key transition sectors is aligned overall. Section 4.3 describes the sector-by-sector analysis and reveals the significant differences observed between the sectors in which a bank is operating.

Among the 95 significant institutions within the scope of this analysis, a striking 90% are found to be misaligned, increasing their transition risk. The alignment assessment was performed on each of the individual credit portfolios of the euro area banks. This shows the extent to which a bank's lending is aligned with the decarbonisation pathway and that the alignment varies considerably from one institution to another. Chart 4.4 provides a breakdown for these 95 institutions, revealing that only eight banks are aligned. For comparison if a bank were to invest an equal amount in each corporation with physical assets in the euro area, it would

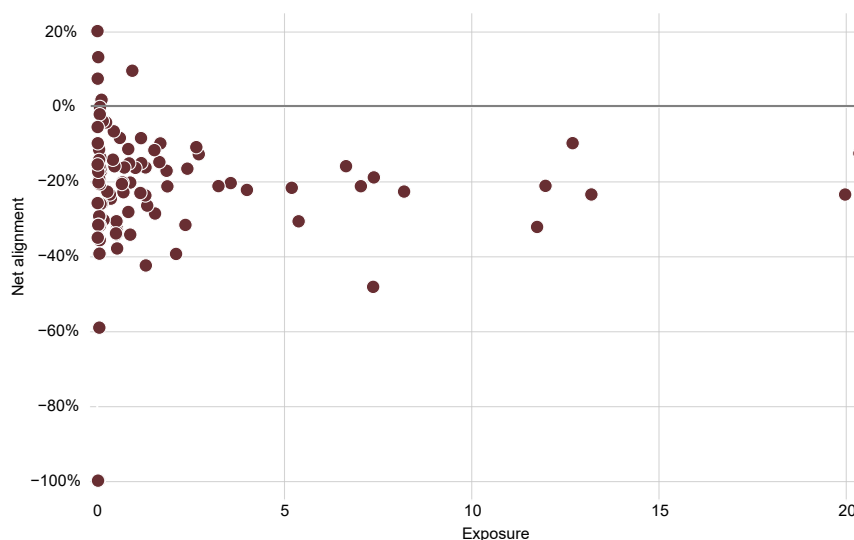
end up with a net alignment rate of -20%. The three most misaligned banks have a limited exposure of less than €50 million in the six key transition sectors. The misaligned banks might therefore have increased reputational risk, as they are not sufficiently financing the transition towards a decarbonised economy. All of the banks with larger portfolio exposures in key transition sectors are misaligned, showing that transition risks are present within their credit portfolios. Both the most aligned banks and the most misaligned banks have relatively small exposures, often involving just a few counterparties. 32 banks have an exposure smaller than €0.1 billion and 60 banks have exposures of less than €1 billion. These banks can more readily adjust their alignment, either by extending credit to more aligned counterparties and engaging in constructive dialogue with a limited number of counterparties or adjusting their credit terms to encompass the transition risk. Interestingly, banks with larger exposures and comparatively better alignment demonstrated the most advanced forward-looking approaches during the 2022 thematic review. This suggests that such practices can indeed lead to tangible reductions in risk profiles.

Chart 4.4

Net alignment of euro area banks

Breakdown by bank and exposure volume

(net alignment in percentages, exposure in EUR billions)



Sources: IEA, AI, RMI and ECB calculations.

Notes: Each dot represents one significant institution. The net alignment is computed using the IEA NZE 2050 decarbonisation pathway for the oil and gas, coal mining, power generation, automotive, steel, and cement sectors. Net alignment of higher than 20% is reduced to 20, and net alignment of lower than -100% is raised to -100% for visualisation purposes.

The exposure relative to Common Equity Tier 1 (CET1) capital shows that some of the most misaligned bank portfolios exhibit a high ratio of exposure over CET1. Chart 4.5 shows, the net alignment of each bank versus the exposures in the key sectors divided by the CET1 capital of the bank,⁴⁴ which allows for a more comprehensive understanding of the risks faced by institutions. On average, banks

⁴⁴ CET1 capital is based on COREP reporting.

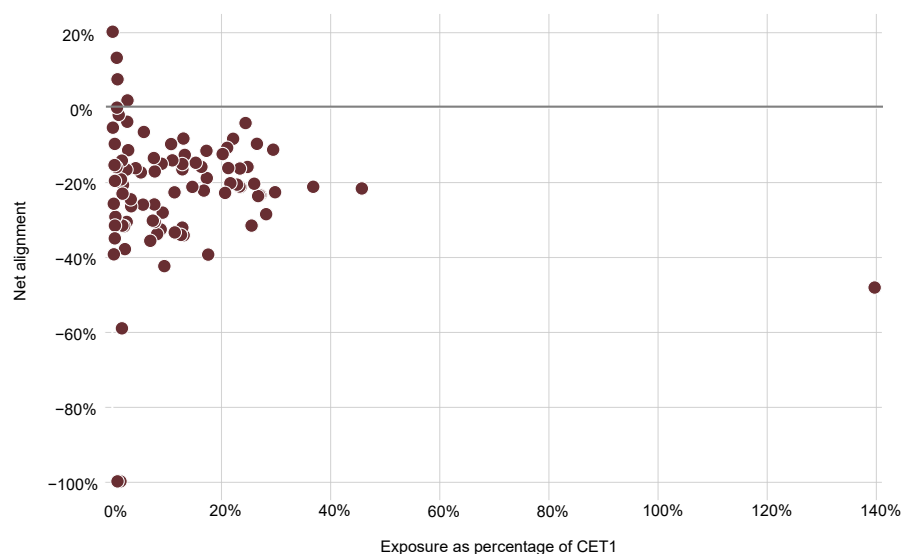
have an exposure to the key six sectors equal to 15% of their CET1 capital, but there is significant variation among banks.

Chart 4.5

Net alignment of euro area banks relative to CET1 capital

Breakdown by bank and by exposure volume over CET1

(net alignment in percentages, exposure as percentage of CET1)



Sources: IEA, AI, RMI and ECB calculations.

Notes: Each dot represents one significant institution. The net alignment is computed using the IEA NZE 2050 decarbonisation pathway for the oil and gas, coal mining, power generation, automotive, steel, and cement sectors. The CET1 is based on COREP data. Net alignment of higher than 20% is reduced to 20% and net alignment of lower than -100% is raised to -100% for visualisation purposes.

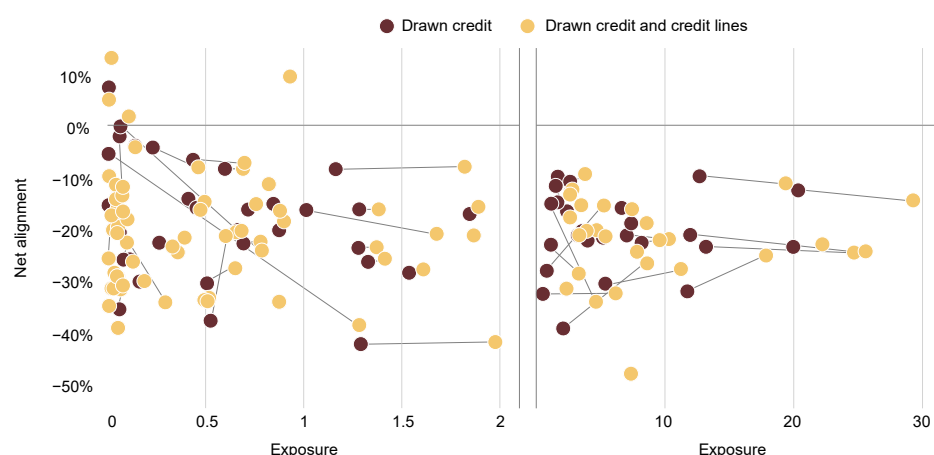
The exposures of banks to misaligned counterparties can increase by more than 50% if credit lines towards these counterparties are fully drawn. In addition to their outstanding loan amounts, banks often extend credit lines to corporations, which constitute a sizeable portion of their exposure. Chart 4.6 illustrates the net alignment of banks, both including and excluding these credit lines. Particularly for banks with larger exposures, credit lines can effectively double their overall exposure, while having a similar level of transition risk. The net alignment can be significantly affected by the inclusion of credit lines, although the average remains similar. This can be attributed to the fact that, in four out of five cases, the corporations with credit lines are already using them or have other loans with the same bank. Therefore, by including the credit lines leads to an increase in their weighting, while the corporations to which the bank lends would hardly change. As these credit lines are contractually agreed, they can lead to a substantial increase in the materiality of the risks.

Chart 4.6

Net alignment of euro area banks with and without credit lines

Breakdown by bank and by exposure volume with and without credit lines for total exposure below €2 billion on the left and above €2 billion on the right.

(net alignment in percentages, exposure in EUR billions)



Sources: IEA, AI, RMI and ECB calculations.

Notes: Each dot represents one significant institution. The net alignment is computed using the IEA NZE 2050 decarbonisation pathway for the oil and gas, coal mining, power generation, automotive, steel, and cement sectors. The lines between the dots indicate that the dots belong to the same bank. The left-hand scale differs from the right-hand scale in order to visualise the movement in the smaller exposures in euro terms.

Seven in ten banks are exposed to the risk of future litigation because they have committed to the Paris Agreement but their credit portfolio is not in line with it. The net misalignment rates presented in this analysis indicate the projected deviation from a net-zero decarbonisation pathway over a five-year horizon. These rates do not, therefore, reflect the high carbon intensity of production at the start of the period but rather the planned efforts to align with the transition. Banks that persist in financing production infrastructure that could hinder the transition are already under increased scrutiny from interest groups and may face growing litigation challenges.⁴⁵ Surprisingly, even banks that have publicly declared a net-zero commitment often remain significantly misaligned. In Chart 4.7, the net alignment of banks with and without a Paris Agreement commitment is shown using distinct colours. The majority (72) of the 95 significant institutions have made a commitment to reach net zero. These commitments do not seem to translate into lower transition risks for the banks. Of the 72 banks with a net-zero commitment, 67 (93%) are not yet aligned with the IEA NZE 2050 pathway. The strategies and internal processes of these banks do not currently ensure that they can fulfil their external commitments. They therefore run the risk of reputational damage and litigation if they fail to align their credit portfolio in the coming years.

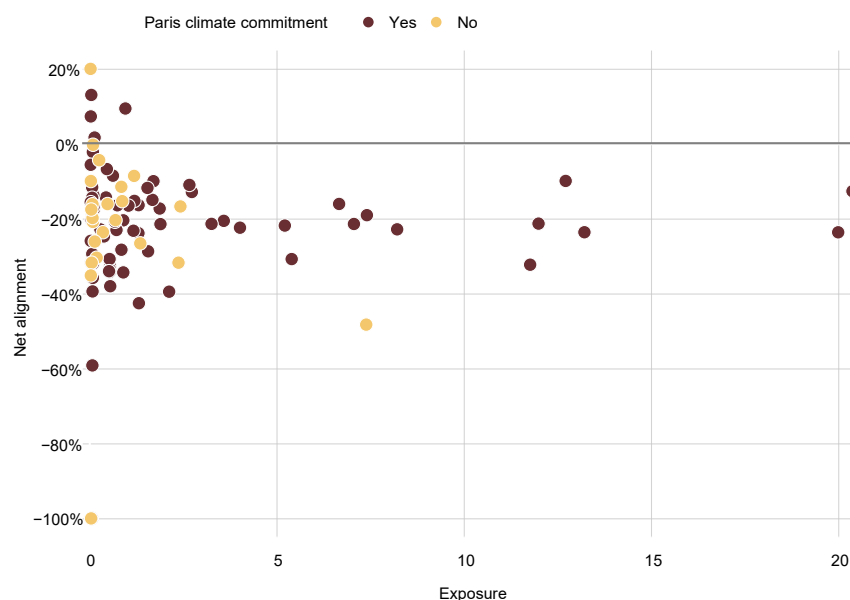
⁴⁵ Network for Greening the Financial System, "Climate-related litigation: Raising awareness about a growing source of risk", November 2021.

Chart 4.7

Net alignment of euro area banks with and without Paris commitment

Breakdown by bank, exposure volume and by whether they have a commitment to the Paris climate accords

(net alignment in percentages, exposure in EUR billions)



Sources: IEA, AI, RMI and ECB calculations.

Notes: Every dot represents one significant institution. The net alignment is computed using the IEA NZE 2050 decarbonisation pathway for the oil and gas, coal mining, power generation, automotive, steel, and cement sectors. Net alignment of higher than 20% is reduced to 20%, and net alignment of lower than -100% is raised to -100% for visualisation purposes.

4.3 Sector-by-sector results

Almost all banks are misaligned in the six key transition sectors except for the steel sector, with the power sector being the primary contributor to this misalignment. Sector-by-sector analysis was conducted to gain a better understanding of the sources of this misalignment. The alignment assessment was performed separately for the six sectors, yielding results on the level of alignment within the individual sectors. While misalignment risks are present in every sector, the power sector stands out as the primary driver of negative net alignment rates.

Chart 4.8 shows the significant differences between sectors both in terms of exposure amounts and net alignment. The steel sector is the only sector for which banks are predominantly aligned. By contrast, in the other five sectors, banks are generally misaligned, although the degree of misalignment varies considerably. In sectors lacking viable zero-emission alternatives, such as steel and cement, alignment is comparatively better, reflecting the more challenging, and therefore slower, decarbonisation progress. Under the IEA NZE 2050 decarbonisation pathway, these sectors have until 2050 to move towards low-carbon production, while fossil fuel cars will already need to have been phased out by 2035. These

slower required decarbonisation rates generally lead to lower misalignment rates, improving the overall alignment in these sectors.

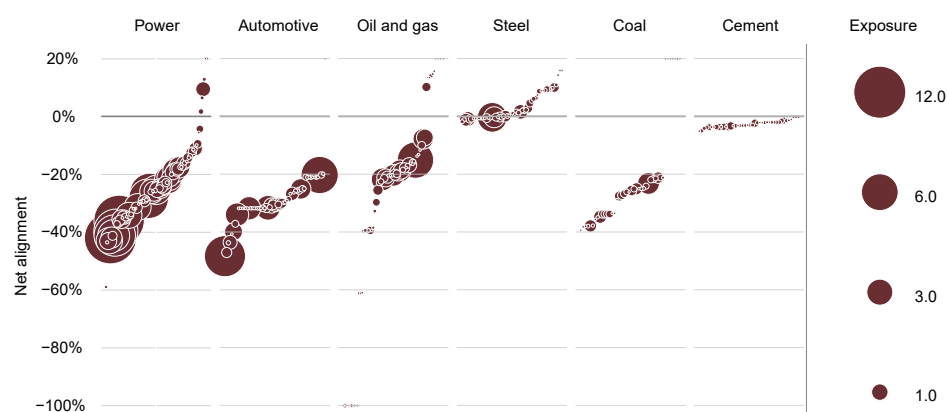
Chart 4.9 explores whether, for the automotive, oil and gas, and power sectors, the misalignment is due to a lack (abundance) of build-out (phase-out) technologies.

Chart 4.8

Net alignment of euro area banks: breakdown by sector

Breakdown by bank and by exposure volume for key sectors

(net alignment in percentages; exposure in EUR billions)



Sources: IEA, AI, RMI and ECB calculations.

Notes: Each dot represents one significant institution. The net alignment is computed using the IEA NZE 2050 decarbonisation pathway for the oil and gas, coal mining, power generation, automotive, steel, and cement sectors. The size of the dot represents the size of the total exposures of the bank in these sectors. The horizontal order of the data is based on their net alignment, with the lowest alignment on the left and the highest on the right. Net alignment higher than 20% is reduced to 20%, and net alignment lower than -100% is raised to -100% for visualisation purposes.

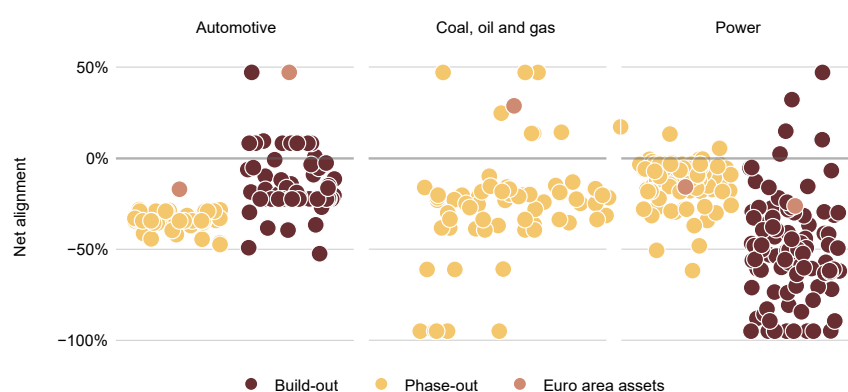
Banks are primarily providing financing to corporations that are falling behind in the build-out stage in the power sector and lagging in the phase-out stage in the automotive sector. The extent of these differences within a sector can vary significantly (see Chart 4.9). In the power sector, the phase-out of fossil fuel plants aligns significantly better with the decarbonisation pathway than the build-out of low-carbon electricity generation. This suggests that banks are extending credit to corporations that are already planning to phase out their coal power plants but have yet to finalise plans for the required amount of renewable energy production. This pattern aligns with the overall trajectory of euro area assets, for which the build-out and phase-out fall somewhere in the middle. The lack of build-out efforts could reduce the competitiveness of corporations in these sectors such that they lose market share to other corporations or new entrants. Conversely, in the automotive sector, the opposite trend is observed. The build-out of electric vehicle production capacity is more frequently in line with the decarbonisation pathway than the phase-out of internal combustion engine cars. However, there are substantial variations in the phase-out efforts among corporations, with some making minimal progress on electric car production, while others are well aligned with the decarbonisation pathway. The lack of phase-out increases the risk of stranded assets, leading to possible collateral devaluation and the potential for significant losses for the corporation.

With regard to euro area assets, there is a noticeable difference, as they are accelerating the shift toward electric vehicles while phasing out internal combustion engine cars at an increasingly rapid rate. The main reason for this disparity is the slower adoption of electric vehicles outside the EU.⁴⁶ The production facilities outside the euro area will therefore often take longer to phase out internal combustion engine cars, and some of the larger non-euro area car manufactures have yet to start large-scale electric vehicle production.

Chart 4.9

Net alignment of euro area banks: breakdown by sector and build-out and phase-out efforts

(net alignment in percentages; exposure in EUR billions)



Sources: IEA, AI, RMI and ECB calculations.

Notes: Each dot represents one significant institution; the horizontal position of the dot is purely for visualisation purposes. The net alignment is computed using the IEA NZE 2050 decarbonisation pathway for the oil and gas, coal and power and automotive sectors. The size of the exposures is not taken into account. Net alignment higher than 50% is reduced to 50% and net alignment lower than -100% is raised to -100% for visualisation purposes.

4.3.1 Power generation

The financed counterparties are rapidly phasing out coal, but are lagging in the build-out of renewable power generation, opting instead for gas power plants. The financed power portfolio comprises 394 corporations, of which 279 are domiciled in the euro area. In 2022 the technology mix of financed power generation corporations still relied on a significant share of carbon-intensive technologies. Roughly 50% of installed production capacity is based on coal-fired, oil and gas capacity, with the largest share accounted for by gas.⁴⁷ Chart 4.10 shows the alignment of the different technologies in the power sector for both the corporations to which banks extend credit (not limited to the euro area) and euro area assets. Coal capacity is decreasing much faster than required under the decarbonisation pathway, likely as a result of the commitment by EU countries to phase out their coal

⁴⁶ Outside of the EU, electric vehicle sales account for over 20% of total car sales in the United Kingdom and China only (see [IEA Global EV Outlook](#)).

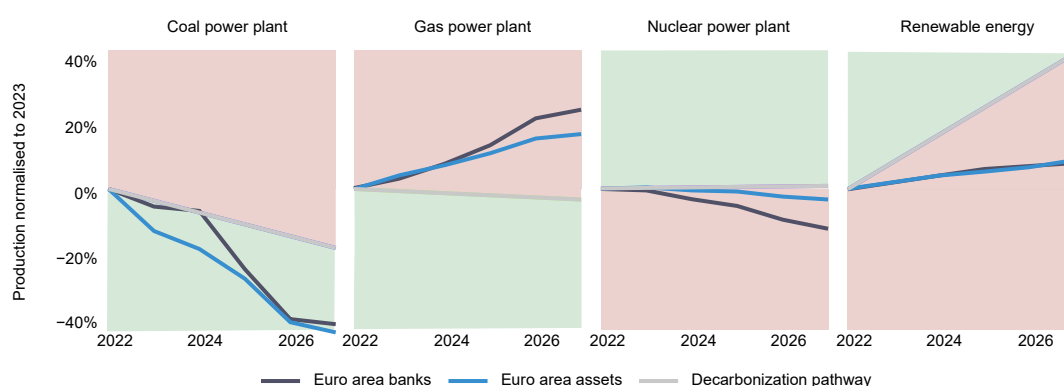
⁴⁷ Based on exposure weighting of production capacity, unweighted the gas sector accounts for around 45%.

power plants.⁴⁸ The decrease in coal capacity goes hand in hand with an increase in gas capacity, as gas is still seen as a transition fuel and can counter the fluctuations in renewable energy capacity. Globally, only a few jurisdictions are phasing out coal while not building out their gas capacity, mainly for idiosyncratic reasons.⁴⁹ The decarbonisation pathway requires a switch to renewables, but the increase in renewables is much smaller than required. An additional 40% of renewable power would need to be installed, compared with just a single digit increase in both the portfolios of banks and euro area assets. With the move towards more decentralised forms of power generation, for example rooftop photovoltaic energy generation, the percentage of assets in the power sector owned by corporations is decreasing.⁵⁰ However, alone this would not make up the more than 30 percentage point gap between the decarbonisation pathway and the euro area banks.

Chart 4.10

Misalignment of the power sector by technology with the IEA NZE 2050 decarbonisation pathway

(normalised production change in percentages; years)



Sources: IEA, AI, RMI and ECB calculations.

Notes: Lines in the red area indicate a lag compared with the decarbonisation pathway; lines within the green area indicate adjustment faster than that required under the decarbonisation pathway. Euro area assets are weighted by production capacity in 2022 and 2027.

4.3.2 Oil, gas and coal

Although oil and gas production is decreasing within the euro area, financed production by banks is increasing outside the euro area. The financed oil, gas and coal portfolio comprises 105 corporations, of which 44 are domiciled in the euro area. While the decarbonisation of the economy requires a rapid phase-out of fossil fuel production, total financed production is projected to significantly increase for oil (+10% compared to the base year) and remains constant for gas. However, phase-out in the coal sector is still lagging 18 percentage points behind the decarbonisation

⁴⁸ According to the European Commission web page on [coal regions in transition](#), nine euro area countries have already phased out coal and eight more will do so before 2030.

⁴⁹ For example, the Netherlands is no longer building its gas capacity, as the extraction of gas in the country has all but stopped in recent years.

⁵⁰ If a photovoltaic system is owned by a private person, rather than a corporation, it does not show up in the analysis.

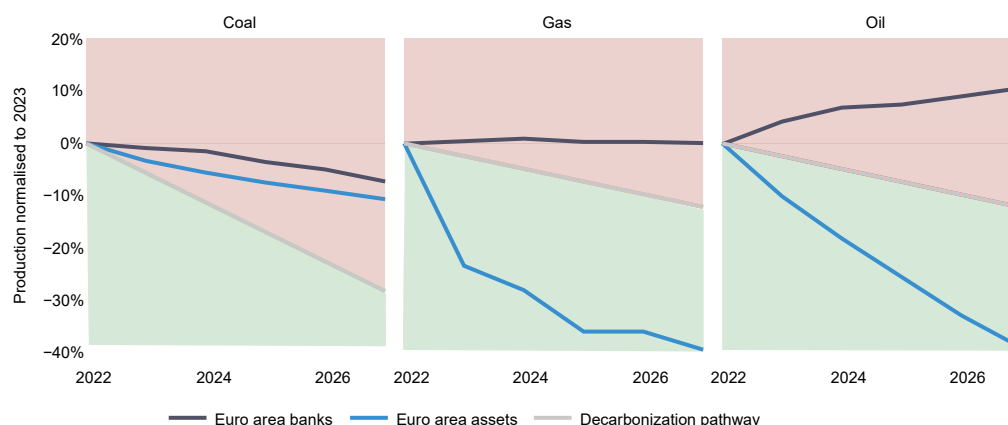
pathway (see Chart 4.11). For the oil and gas sector, production within the euro area is decreasing much more rapidly than required under the decarbonisation pathway. Euro area banks are thus financing significant oil and gas assets outside of the euro area, resulting in a major difference between the oil and gas alignments of the euro area assets and all the assets financed by euro area bank.

Despite the rapid decrease in production for the oil and gas sector within the euro area compared to the decarbonisation pathway, the phase-out still lags behind the decarbonisation pathway by 18 percentage points. This shows clearly that euro area banks are continuing to significantly finance oil and gas assets outside the euro area. This is also to be expected, as the major oil and gas corporations headquartered within the euro area all have non-euro area oil and gas assets according to the PAMS dataset.

Chart 4.11

Misalignment of the coal, oil and gas sectors with the IEA NZE 2050 decarbonisation pathway

(normalised production change in percentages; years)



Sources: IEA, AI, RMI and ECB calculations.

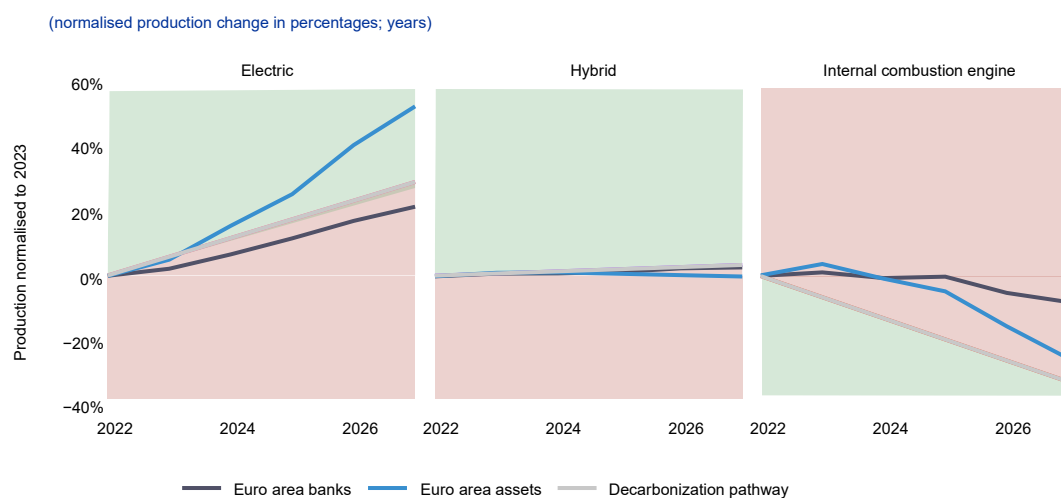
Notes: Lines in the red area indicate a lag compared with the decarbonisation pathway; lines within the green area indicate adjustment faster than that under the decarbonisation pathway. The euro area assets are weighted by production capacity in 2022 and 2027.

4.3.3 Automotive

Electric vehicle production is increasing in line with the decarbonisation pathway, but internal combustion engine car production by the counterparties financed by euro area banks shows barely any decrease. The financed automotive portfolio comprises 25 corporations, of which 16 are domiciled in the euro area. The vast majority (87%) of light duty vehicles produced by the automotive industry financed by euro area banks have internal combustion engines. Just under 10% of vehicles produced are electric, a small minority are hybrid and hardly any are based on fuel cell technology. While the decarbonisation pathway does foresee a role for hybrid and fuel cell-based technologies, the expected increase is very limited, accounting for a market share of 5% and 2% at the end of the five-year time horizon respectively. Decarbonisation is expected to be largely achieved through rapid build-out of electric vehicle production (of around 30% in five years) and rapid phase-out of the production of internal combustion engines (-30% in five years). Although the market size of the automotive industry is expected to grow under the decarbonisation pathway, the main shift in decarbonisation comes from this transition away from the internal combustion engine towards electric vehicles. The financed counterparties also show a shift in production towards electric vehicles. However, the increase in electric vehicles is still lagging 8 percentage points behind the decarbonisation pathway, while the phasing out of internal combustion engine vehicles is lagging by more than 25 percentage points. Comparing the financed counterparties to production capacity within the euro area, euro area assets are aligned when it comes to the production of electric vehicles, with a build-out almost twice that required under the decarbonisation pathway. This could stem from EU regulations requiring all new cars to be zero emission from 2035 onwards.

Chart 4.12

Misalignment of the automotive sector by technology with the IEA NZE 2050 decarbonisation pathway



Sources: IEA, AI, RMI and ECB calculations.

Notes: Lines in the red area indicate a lag compared with the decarbonisation pathway; lines within the green area indicate adjustment faster than that under the decarbonisation pathway. Euro area assets are weighted by production capacity in 2022 and 2027.

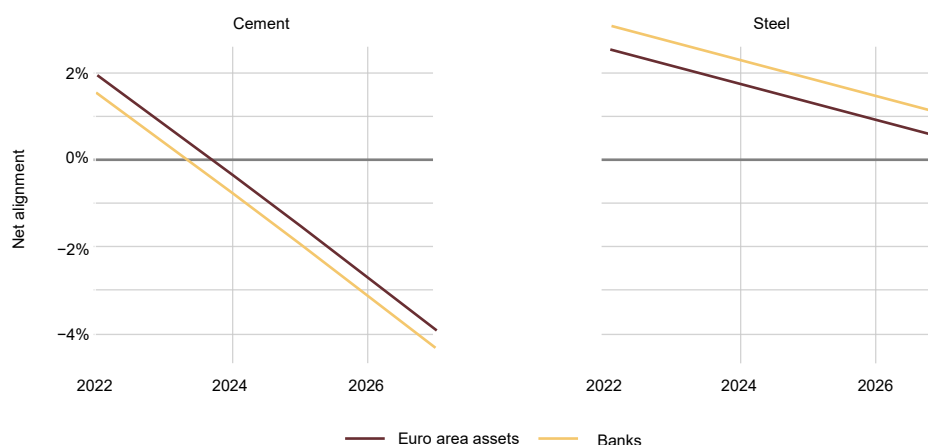
4.3.4 Cement, steel

In the steel sector, banks are financing counterparties that are clearly outperforming the decarbonisation pathway, while in the cement sector this is not the case. The combined portfolio of financed cement and steel includes 87 corporations, with 63 of them based in the euro area. The exposure of banks to corporations in the steel sector is over five times larger than their exposure to corporations in the cement sector. Chart 4.13 shows the net alignment for both the steel and cement sectors. In the cement sector, both the counterparties financed by the banks and the euro area assets as a whole are performing worse than required under the decarbonisation pathway. To align with the decarbonisation pathway, they must decrease the carbon intensity of their production. By contrast, the steel sector shows a different trend. Euro area assets are slightly ahead of the decarbonisation pathway, but the financed counterparties are surpassing it. Steel production by the financed counterparties is already operating at a level of carbon intensity that is not expected to be achieved until 2033 under the decarbonisation pathway. This suggests that banks are providing more credit to steel manufacturers that are actively adjusting their production processes to achieve lower carbon intensity.

Chart 4.13

Misalignment of the cement and steel sectors with the IEA NZE 2050 decarbonisation pathway

(net alignment in percentages; years)



Sources: IEA, AI, RMI and ECB calculations.

Notes: When the lines are below zero, the portfolio is lagging behind the decarbonisation pathway; for lines above zero, the portfolios are adjusting quicker than under the pathway. The euro area assets are weighted by production capacity in 2022 and 2027.

4.4 Technology-by-technology results

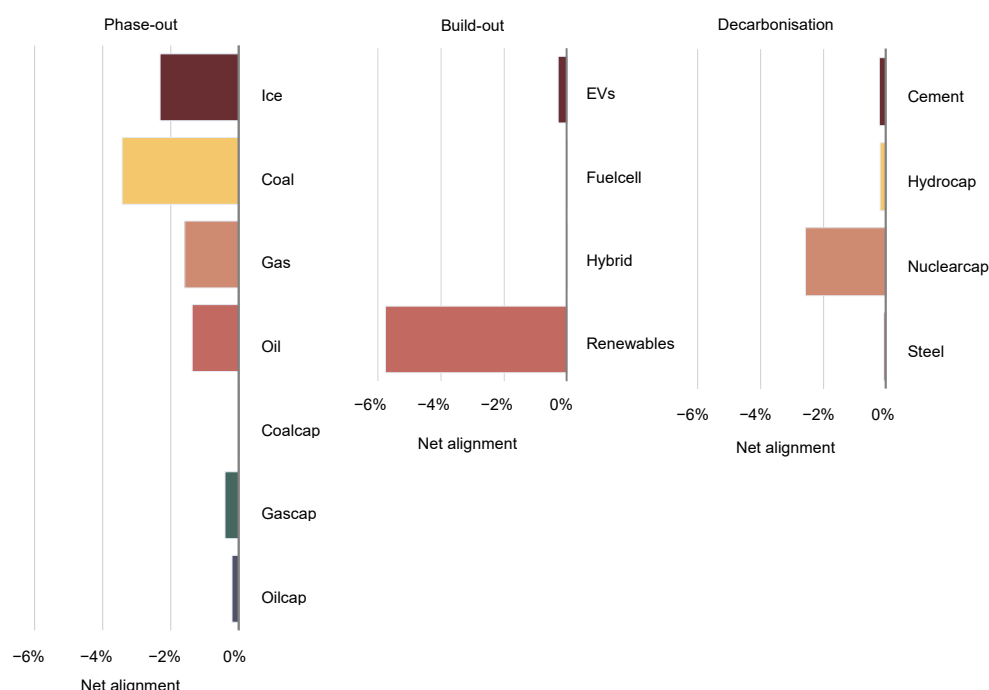
The results of the alignment assessment can also give a more detailed picture of the split between phase-out and build-out technologies. This involves performing analysis at the technology level and not aggregating further. The primary sources of bank financing misalignment are inspected separately for the build-out and phase-out technologies.

Approximately 10 percentage points of the sector-wide misalignment can be attributed to the financing of corporations that are slow to phase out their production of carbon-intensive technologies. A significant part of this misalignment arises from the financing of corporations that are lagging behind on phasing out coal, oil and gas mining/extraction. Of these, coal mining plays a dominant role, contributing almost 4 percentage points to the overall misalignment within the banking sector. Additionally, within the automotive sector, financing of the phase-out of internal combustion engines is progressing more slowly, resulting in an additional 2.5 percentage points of misalignment. The lack of phase-out efforts increases the risk that the assets in these areas become stranded, in turn leading to an increase in credit risk for the financial institutions that extend credit to those corporations.

Chart 4.14

Net alignment contribution by technology

(net alignment in percentages)



Sources: IEA, AI, RMI and ECB calculations.

Notes: The net alignment is computed using the IEA NZE2050 decarbonisation pathway. The analysis is based on euro area banks' credit portfolios as at December 2022. Hydrocap = hydro power plants; nuclearcap = nuclear power plants; ice = internal combustion engine vehicles; coal = coal mining; gas = gas extraction; oil = oil extraction; coalcap = coal-fired power plants; gascap = gas-fired power plants; oilcap = oil-fired power plants; EVs = electric vehicles; fuelcell = hydrogen fuel cell vehicles; hybrid = plug-in hybrid vehicles; and renewables = renewable energy generation.

Over 30% of the total misalignment within the euro area banking sector stems from a lack of financing for renewable energy sources. The misalignment in build-out technologies is driven by insufficient financing for corporations that intend to transition to renewable energy sources. This is particularly the case for the power sector, which represents – by a considerable margin – the largest share of misalignment within the euro area banking sector. While the financing of electric cars contributes to a smaller share of the misalignment, hydrogen and hybrid

technologies have minimal impact on misalignment owing to their anticipated low production levels.

For decarbonisation technologies, the steel sector is aligned, while the other technologies are misaligned. Decarbonisation technologies encompass technologies that are challenging to decarbonise (such as steel and cement), which are not easily constructed within a five-year timespan (for example, nuclear power) or are physically unfeasible (such as hydroelectric power). Collectively, these technologies contribute to a relatively minor share (around 3 percentage points) of the total misalignment. It is worth noting that the steel sector exhibits broad alignment and makes a positive contribution to the overall alignment balance. Conversely, nuclear power plays a prominent role among technologies contributing to negative misalignment. This is due to the aging of current reactors and the extensive changes taking place in the energy sector. To calculate net alignment, all contributions from the technologies within the power sector are combined. A corporation in the energy sector can thus be aligned by compensating for its misalignment in one technology through alignment in another. If a corporation does not increase its nuclear production, but increases its renewable energy production by more than required under the decarbonisation pathway, the misalignment from nuclear production can be completely offset. In this way, the alignment assessment is “technology-agnostic”.

4.5 Corporation-by-corporation results

The average exposure of a bank to a misaligned counterparty is more than double that of an aligned counterparty. Based on an analysis of the results from the alignment assessment at counterparty level, it can be concluded that the average exposure to an aligned counterparty amounts to €45 million, whereas the average exposure to a misaligned counterparty is €94 million. This indicates that banks are providing more loans to misaligned counterparties than they are to aligned ones. Additionally, with direct and indirect increases in carbon-related costs, the profitability of these counterparties could come under pressure, affecting their ability to generate returns. This pressure could arise either from a slow phase-out, as corporations find themselves stuck with assets of reduced economic value, or from a slow build-out, which may result in a loss of competitiveness compared to corporations that are progressing more rapidly. It is worth noting that, irrespective of their overall portfolio alignment rates, banks that are aligned with sustainability goals may still face heightened transition risks. This is because certain subsets of their counterparties and portfolios within specific sectors may exhibit significant misalignment, as illustrated by the wide variation in alignment between build-out and phase-out technologies observed in some corporations.

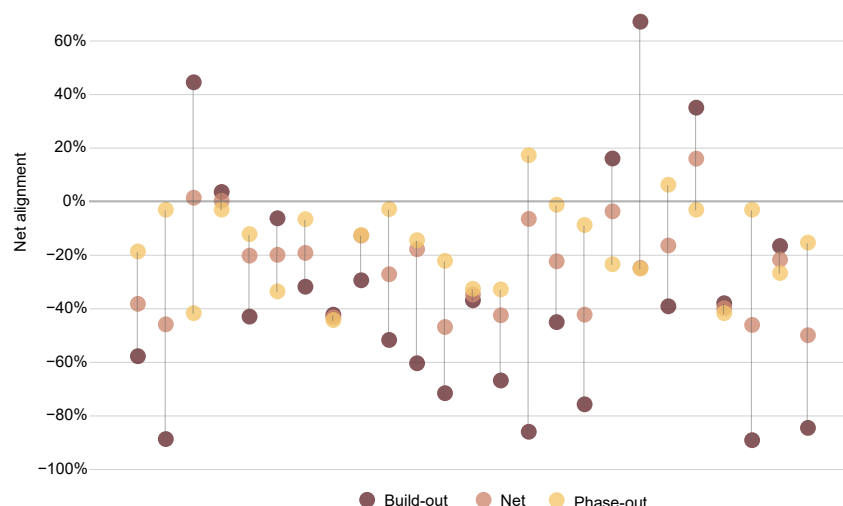
While the level of alignment varies significantly among corporations, the financing of misaligned production is concentrated in a relatively small number of counterparties. In total, there are 542 unique counterparties within the scope of this analysis, with over 6,000 bank-counterparty relationships. In essence, each counterparty has an

average of approximately 12 relationships with various banks. These relationships may involve multiple banks or multiple loans with the same bank.

Chart 4.15

Net alignment for 25 corporations including build-out and phase-out alignment

(net alignment in percentages)



Sources: IEA, AI, RMI and ECB calculations.

Notes: The corporations are drawn randomly from the subset of corporations to which the banks extend credit. The horizontal location of the dots is selected for visualisation purposes.

The majority of banks are facing elevated risks stemming from misalignment, particularly the risk of asset stranding. Chart 4.15 illustrates the net alignment rates, showing the projected deviation from the decarbonisation pathway in five years' time for a subset of corporations categorised based on their progress on build-out and phase-out. This chart highlights that most of the financed counterparties are either not adjusting to the transition at all or doing so too slowly. Depending on the corporation, the root cause of this sluggish adjustment can be attributed to a delay in build-out, a delay in phase-out, or both. The level of alignment between build-out and phase-out can vary significantly, often resulting in one being reasonably aligned while the other is not. Within these corporations, phase-out generally aligns more closely with the decarbonisation pathway than build-out, but the reverse scenario is also common. These counterparties are increasingly operating assets that play a critical role in helping governments achieve decarbonisation objectives. However, over time, these assets may risk becoming stranded as a result of corporations' failure to adapt.

Corporations can also experience significant variations in alignment over time, particularly as new production capacity is established or existing capacity is phased out. Table 4.2 shows the percentage of financed counterparties that transition from alignment to misalignment and vice versa. A small percentage of counterparties experience shifts in their alignment status. These shifts may occur when counterparties have financed production capacity that is scheduled to come online after a few years, leading to an increase in alignment. Among misaligned counterparties, only 26 exhibit alignment of -60% or lower. The relatively small

number of counterparties with significant levels of misalignment underscores the feasibility of implementing client-specific actions, for instance by changing loan terms to ensure that the transition risks are adequately covered. Furthermore, because the misalignment rate is computed in a forward-looking manner, it can be rapidly improved upon. Once confirmed production plans are in place with a start date that falls within the next five years, the deviation from the decarbonisation pathway immediately decreases. These substantial changes in alignment also explain the need to focus on the end of the five-year period. If a corporation is shifting its production to use different technologies, the changes would not take place gradually, but rather in sudden steps as new production facilities open. A multi-year horizon should therefore be used to gain insight into how well a corporation is transitioning towards a low-carbon production in order to average such abrupt changes in production. The risks associated with the misalignment of a corporation can materialise at any moment, as new market conditions resulting from, among other things, stricter regulation and higher carbon prices emerge and corporations may not have plans in place to adjust to them.

Table 4.2
Corporations moving from alignment to misalignment over time

	Percentage of corporations becoming aligned	Percentage of corporations becoming misaligned
2024	3.2%	2.2%
2025	1.0%	1.6%
2026	1.8%	1.6%
2027	1.2%	2.0%

Sources: IEA, AI, RMI and ECB calculations.

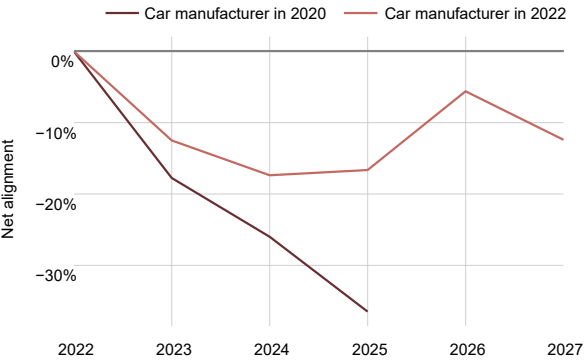
Box 3

Getting to alignment: A case study of a large car manufacturer

A large car manufacturer that produces trucks, utility vehicles, cars and vans. The corporation is committed to achieving carbon neutrality by 2050, as enshrined in the framework of the Sustainable Financing Framework. This Framework, which was published in 2021, presents an ambitious plan for vehicle electrification as well as other environmental and social initiatives. The road towards carbon neutrality includes: i) the electrification of vehicles; ii) investment in sustainable manufacturing; and iii) working with suppliers to reduce their emissions. This Sustainable Financing Framework changed the projections for electric and internal combustion engine. In 2020, before the manufacturer published the Framework and adopted an electric vehicle-focused strategy, the corporation's alignment was decreasing (see Chart B.1). But, once it started to implement the Framework, its projections for electric vehicles rose and those for internal combustion engines declined as the manufacture doubled its investment in electric vehicle production. This has had a positive effect on its alignment. Today, instead of the stark decreasing trend observed in 2020, the trend is still decreasing, but is starting to turn, and the projected alignment for 2026 is better than that for 2023, as the production envisaged in their Sustainable Financing Framework starts to come online (see Chart B.1).

Chart B.1
Net alignment of a large car manufacturer in 2020 and 2022

(net alignment in percentages; years)



Sources: IEA, AI, RMI and ECB calculations.

The stark increase in the alignment of the car a large car manufacturer between the 2020 projections and the 2022 projections shows that when a corporation brings their strategy more into line with the Paris Agreement, the effects can be seen in the alignment assessment. This demonstrates that it is possible for a corporation to vastly improve their alignment over time, and even for a large corporation to do so in just two years.

Sources: ECB, AI

5 Banks' alignment approaches

Banks broadly acknowledge the materiality of their exposure to transition risk and are developing practices to enhance the resilience of their strategies and risk profiles. The ECB's 2022 thematic review on climate-related and environmental risks shows that a growing number of banks find themselves materially exposed to transition risk.⁵¹ More specifically, over 80% of banks conclude that transition risk has a material impact on their strategies and risk profiles. In line with this observation, the ECB's 2023 disclosure exercise shows that a growing number of banks have committed to transition their portfolios to net-zero emissions by 2050.⁵² To implement these net-zero commitments, banks are developing practices to enhance resilience to transition risk and to steer their portfolio in the direction of a net-zero carbon economy.

In this context, the 2022 thematic review demonstrates that banks have started to use transition planning tools, including assessment of alignment. To this end, banks use scientific pathways to measure the alignment of their portfolios with the Paris Agreement, in particular using methodologies such as PACTA. As the findings of the 2023 disclosure exercise show, 32% of the sampled banks within the scope of the EBA ITS disclosed that they had conducted this kind of analysis using such methodologies. Using portfolio alignment analysis, banks have set targets for the sectors that are materially exposed to transition risks. These targets indicate the evolution of the banks' portfolio over time with a view to achieving the banks' long-term strategic objectives, such as a net-zero alignment commitment. Subsequently, banks have embedded these targets in their monitoring processes in order to track their own progress against them. Typically, the targets feed into climate-related and environmental key risk indicators, for instance tracking the alignment of a bank's portfolio emissions intensity relative to the forward-looking transition trajectories with which banks plan to comply. Following up on misalignments with the forward-looking transition trajectories, banks have established transition policies and procedures. Clients' transition plans are then assessed to help inform the adjustment of client-specific actions needed to steer clients towards banks' forward-looking transition trajectories and thus mitigate the risks from misalignment.

Banks are broadly adopting client engagement approaches geared towards reducing risk and financing the transition. The 2022 thematic review shows that banks often exclude new financing of the activities in sectors that are viewed as counterproductive to the energy transition, while often deadlines and limits are set for activities that require a (rapid) phase-out (see Chart 5.1). For example, as part of their client engagement, banks require clients to implement time-bound action plans or offer clients transition products to support them in transforming their business model. A small group of leading banks also has dedicated processes in place in case

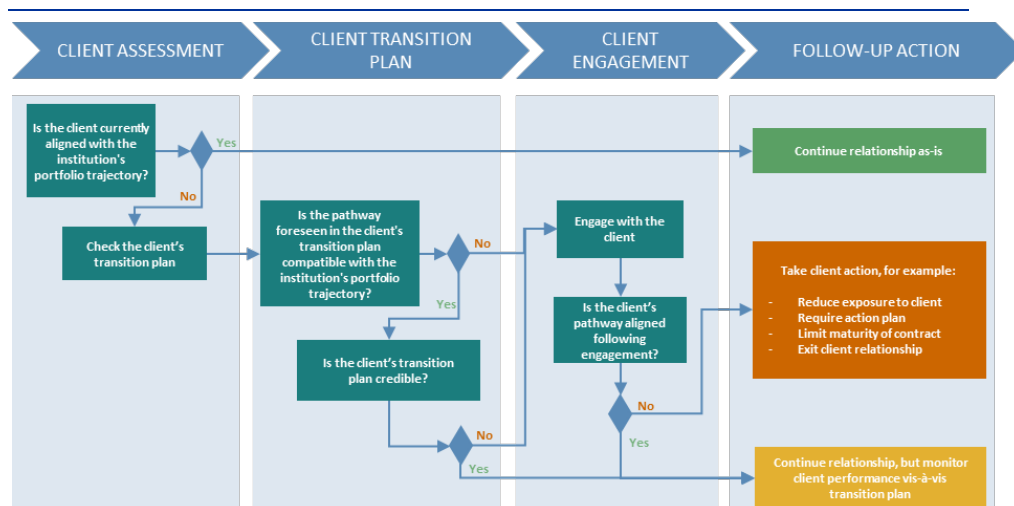
⁵¹ ECB, "Walking the talk: Banks gearing up to manage risks from climate change and environmental degradation", November 2022.

⁵² ECB, "The importance of being transparent: A review of climate-related and environmental risks disclosures practices and trends", April 2023.

of unsuccessful engagement, such as the reduction of client exposure, or, as a last resort, the abandonment of client relationships. For example, the Chart below on the process for managing and exiting client relationships from the ECB report on good practices for C&E risk management shows how banks can take clients' transition plans into account with the purpose of improving alignment.

Chart 5.1

Stylised example showing how clients' transition plans are taken into account in assessing their alignment with the institution's portfolio trajectory



Source: ECB.

While exclusions are used in some cases, banks are adjusting credit policies to respond to the required build-out and phase-out of specific technologies, also for hard-to-abate sectors. Delving deeper into sectoral policies, the illustrations in the ECB report on good practices for climate-related and environmental risk management indicate that banks tend to focus on exclusion and phasing out criteria for sectors that are typically linked to elevated transition risks, such as oil and gas, coal mining and power generation. Nevertheless, a few banks have started to develop relevant sectoral policies for other, hard-to-abate, sectors, such as steel and cement. Moreover, banks increasingly express, albeit often without details, their support for products related to specific build-out and decarbonisation technologies in their lending criteria. Table 5.1 gives an overview of excerpts from banks' sectoral policies.

Table 5.1**Non-exhaustive examples of observed practices related to sectoral policies**

Sector	Exclusions	Phase-out	Build-out and decarbonisation technologies
Oil and gas	Direct financing, insurance or advisory services for exploration and extraction of new oil and gas fields Financing of new corporations with oil and gas expansion plans Financing of new corporations when oil and gas upstream activities are >10% of revenues Financing of existing oil and gas corporations without a credible implementation of a net-zero pathway	Complete phase-out of oil and gas by 2030 (exception: corporations with credible exit strategy by 2040 and no new oil or gas exploration projects or assets beyond 2030)	Financing renewable energy and low-carbon projects
Coal mining	Direct financial services for new coal mines or coal mine expansions Financing of coal mine developers Financing of coal mining corporations when coal production per year is >10 million tonnes	Complete phase-out of coal mining by 2028 (exception: corporations other than coal mine developers with a phase-out plan)	
Power generation	Direct financial services for new coal-fired power plants or power plant expansions Financing of coal-fired power plant developers Financial services for corporations with >5 GW of installed capacity (power generation) or >10% revenue or power generation from coal	Complete phase-out of thermal coal power generation by 2030 in EU and OECD countries and by 2040 worldwide Phase-out of lending to power generation corporations that are >5% reliant on coal-fired power by 2025	Dedicated finance for carbon capture on existing coal-fired power plants Special-purpose loans for the conversion of coal-fired power plants to low-carbon fuels Supporting power corporations in transition towards renewables, for instance by financing solar photovoltaic projects
Automotive			Supporting automotive corporations in transition towards fleets with more sustainable vehicles, for instance by advising on sustainable finance frameworks to fund investments in electric vehicles (EVs)
Steel	Direct financing or advisory services for new metallurgical coal mines	Phasing out blast furnace projects	Supporting hydrogen-electrolysing facilities
Cement			Supporting optimisation of the clinker-to-cement ratio, for instance by underwriting the financing of reductions in the clinker-to-cement ratio Supporting Carbon Capture, Utilisation and Storage (CCUS) technologies
Aviation	Direct financing for new airports and airport capacity expansion projects Loans intended for older (less energy-efficient) aircraft		Special-purpose loans for sustainable aviation fuel (SAF)

Source: ECB.

While not always broadly deployed, good practices have been observed across the spectrum.

The ECB has observed that most banks are continuing to adopt a wait-and-see approach. They do not support their long-term strategic objectives through targets, exclusions and phasing-out criteria, or only do so to an extent that is inconsequential to their exposure profile. The ECB report on good practices for climate-related and environmental risk management, published alongside the 2022 thematic review gives examples of practices that can help banks align with the supervisory expectations set out in the ECB Guide on climate-related and environmental risks.⁵³ Table 5.2 gives an overview of the practices identified to demonstrate what banks can do to integrate climate-related and environmental risks into their business strategies.

Table 5.2

Good practices for the integration of climate-related and environmental risks into banks' business strategies

Section	Sub-section	#	Topic	Expectation
Business strategy	Strategic approaches	3.1.1	Transition planning	2
		3.1.2	Key performance indicators	2
		3.1.3	Products	2
	Strategic steering tools	3.2.1	Client engagement	2, 7.4
		3.2.2	Client transition plans	2, 7.4

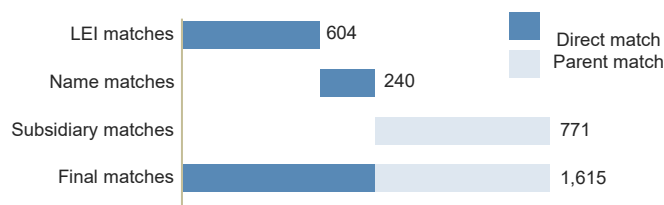
Source: ECB.

⁵³ ECB, "Good practices for climate-related and environmental risk management, observations from the 2022 thematic review", November 2022.

6 Annex 1: Coverage

To be able to perform the alignment assessment, the exposures from AnaCredit should be linked to the physical assets matched with securities (PAMs) dataset. Linking these corporations can be done in a number of ways. Ideally the linking is based on unique identifiers, as this gives assurance that the matched entities are actually the same entities. This identifier matching is based on the Legal Entity Identifier (LEI), which any corporation that trades in securities should have. A majority of the exposure values were matched in this way, as most large corporations have an LEI. After the LEI code matching, fuzzy name matching with manual confirmation was done to match another 240 corporations between the datasets. These matches were all based on a direct match. The next step was to match at the parent level. Both the PAMs dataset and the AnaCredit dataset include corporate structures. This allows the matching of subsidiaries to parent entities. For the entities in AnaCredit, the immediate and the ultimate parent were used to try to find a match. This almost doubled the number of matches, although the exposure amount that was matched did not increase as much, as the exposures to these subsidiaries was generally far smaller than the exposures to the parent entities.

Chart 6.1
Source of matches



Source: ECB.

Analysing how well the matching has gone is not straightforward, as the number of true matches and what the actual true matches are is unknown. A first indication of how well the matching has gone is provided by the amount of exposure in the sectors to which the Paris Agreement Capital Transition Assessment (PACTA) can be applied. The issue is that some of the matches are not classified as being in a PACTA sector. The amount of exposure present in the key transition sectors is €125 billion, while the total matched amount is €189 billion. Another way to judge the result of the matching is by looking at the percentage of production facilities within the area in which they are active that they extend credit to, as most corporations require credit and would usually obtain it from local financiers. The percentage of production financed is given in Table A1.1, broken down by sector and the size of the production facility.

Table 6.1

Percentage of financed production for different production facility sizes

	Large production facilities	Medium-sized production facilities	Small production facilities
Automotive	97%	71%	59%
Cement	74%	48%	-
Coal	82%	47%	45%
Oil and gas	72%	37%	25%
Power	71%	66%	27%
Steel	87%	63%	37%

Source: ECB.

Notes: Large production facilities are production facilities that are larger than 10% of the size of the largest production facility; medium-sized production facilities are larger than 1% but smaller than or equal to 10% of the size of the largest production facility; small production facilities are all the smaller facilities. Production facilities are aggregated per country before determining the size.

From the table it can be seen that the coverage for large production facilities is very high, with more than 70% of large production facilities covered in each of the sectors. As the production facilities get smaller, the coverage decreases. This could be because the data matching becomes more difficult, as small corporations are less likely to have an LEI and less information about the corporation might be available to ensure that a match can be made. Small production facilities might also be excluded from the matching as they might be immaterial to the corporation business model. For instance, a textile factory equipped with some solar panels to generate part of its energy usage counts as a power production site. However, the transition risks that this textile producer is facing in the power sector are not material, as its competitiveness would not be harmed if it did not continue to build out its renewable energy production.

7 Annex 2: Methodological supplement

7.1 PACTA methodology

The PACTA for Banks (P4B) methodology is used in this study to assess the alignment of euro area corporate loan books with the climate scenarios described in Annex 3. The assessment is conducted across six key climate-relevant sectors which together account for more than 70% of global CO₂ emissions: power generation, oil and gas extraction, coal extraction, automotive manufacture, steel production and cement production. Alignment is assessed using a combination of greenhouse gas (GHG) and non-GHG climate indicators. The non-GHG climate indicators are based on a five-year forward-looking physical production/capacity change. The GHG indicators are based on emission intensities, normalised to units of production in the case of steel and cement.⁵⁴ The decarbonisation sectors use the GHG indicators, while the other sectors use the production capacity change (see Table 7.1 for an overview of the technologies in key sectors).

Table 7.1

Overview of the different technologies in key transition sectors

	Phase-out ¹	Build-out	Decarbonisation
Oil and gas	Oil	-	-
	Gas	-	-
Coal	Coal	-	-
Automotive	Internal combustion engine	Hybrid	-
		Electric	-
		Fuel Cell	-
Power	Oil power plants	Hydropower	-
	Gas power plants	Renewables	-
	Coal power plants	Nuclear power plants	-
Steel	-	-	Steel
Cement	-	-	Cement

Source: RMI, IEA

Notes: ¹ The IEA NZE scenario anticipates a 75% reduction in oil production and an 88% reduction in natural gas production by 2050, with some production still being required, mainly to provide petrochemical feedstocks and hydrogen to industry ²from the build-out/phase-out split perspective, these technologies are considered decarbonisation technologies.

The full methodology can be found in the P4B methodology document⁵⁵.

⁵⁴ Physical emission intensities are used in the steel and cement sectors as there are currently no well-defined technology transitions for these sectors, unlike for the other PACTA sectors. As low-carbon technologies reach commercial market maturity in these sectors, better defined technology pathways against which alignment can potentially be assessed are expected to be presented in the scenarios.

⁵⁵ "PACTA for Banks Methodology Document – Climate scenario analysis for corporate lending portfolios", Version 1.1.2, 2DII, July 2022.

The following is a summarised version of the two key steps in the PACTA methodology (Steps 1 and 2), complimented by additional steps to assess the alignment of the euro area banking sector (Steps 3 and 4).

Step 1 – Compile forward-looking corporation-level data and match it to banks' outstanding loans

The physical asset-level data used for measurement is compiled using a combination of business intelligence and financial datasets. Forward-looking production build-out and phase-out plans at corporation level are consolidated from the asset level up the corporate ownership structures on the basis of an equity ownership approach (see Figure 8 in the P4B methodology document). For the purpose of this study, the asset-based data required for the PACTA analysis is provided by [Asset Impact](#).

In order to identify the corporations for which climate alignment is assessed, the counterparties in the banking sector's loan book are identified among the corporations in the asset-level data in order to retrieve their production and technology profiles. This record-linkage process is referred to as "matching". P4B does this on the basis of a fuzzy matching algorithm.

Step 2 – Measure climate scenario alignment of corporations at the technology level

The required changes in production or emission intensities taken from the technology pathways described in climate scenarios are allocated to corporations on the basis of a market share approach (see Section 2.4.3 of the P4B methodology document). The alignment is measured by taking the difference between the scenario-based value for a given technology in 2027 and the planned technology production values of the corporation five years into the future (2027). The indicator at the technology level is a percentage production alignment deviation from the scenario.

For those sectors with clear technology transitions, such as the power, automotive and fossil fuel sectors, this change is allocated and measured by PACTA at the technology or fuel level. For those sectors where scenarios do not have well-defined technology roadmaps, as is the case with steel and cement, the scenarios' physical emission intensity pathways are allocated to corporations based on the scenario trajectory for the physical emissions intensity of the sector⁵⁶. This approach is similar to the technology-based approach, with the main difference being that the transition from one technology to another is not used for the alignment, and instead the difference between the carbon intensity of production of a specific production facility is compared to the carbon intensity for the sector on the basis of a scenario.

Step 3 – Calculate the corporation-level alignment of a transition activity

⁵⁶ This differs from the P4B methodology, which applies a variation of the SBTi's Sectoral Decarbonisation Approach (SDA) as described in the P4B methodology document section 2.5.2

For corporations operating in sectors where clear technology transitions should take place, meaning that certain technologies need to be built out while others need to be phased out – as is the case in the automotive and power sectors – an aggregation can be made where the difference between the planned production values of the respective technologies and the scenario-based values to be achieved by the corporation in order to be aligned are aggregated for each of the directional transition activities (phasing out and building out). The aggregate differences are then divided by the scenario-based net production value for 2027 in order to calculate a building out/phasing out contribution to the net alignment. This gives the two disaggregated values of an aggregate pathway transition alignment.

The sum of the two pathway transition alignment values (phasing out and building out) gives the corporation's net aggregate alignment measurement. The size of each separate part can thus be used to understand the drivers of the net alignment measurement.

No such aggregation is needed for corporations in sectors where the technology pathway is unidirectional and currently only covers the phasing out of their principal activity (coal, oil and gas) or in sectors using emission intensity indicators and the SDA approach (steel and cement).

Step 4 – Allocate the corporation alignment to the sectoral loan book

The portfolio weight approach⁵⁷ is used for the calculation of alignment of corporations with loan books. This approach weights exposure to a corporation using the total drawn amount (see Section 2.3 of the P4B methodology document). The loan book can be defined for the different views shown in the analysis as described below:

System level: Total system-wide debt outstanding to corporation A / total system-wide debt outstanding to sector x.

Bank-by-bank level: Total bank debt outstanding to corporation A / total bank debt outstanding to sector x.

Corporation-by-corporation level: No weighting factor is used.

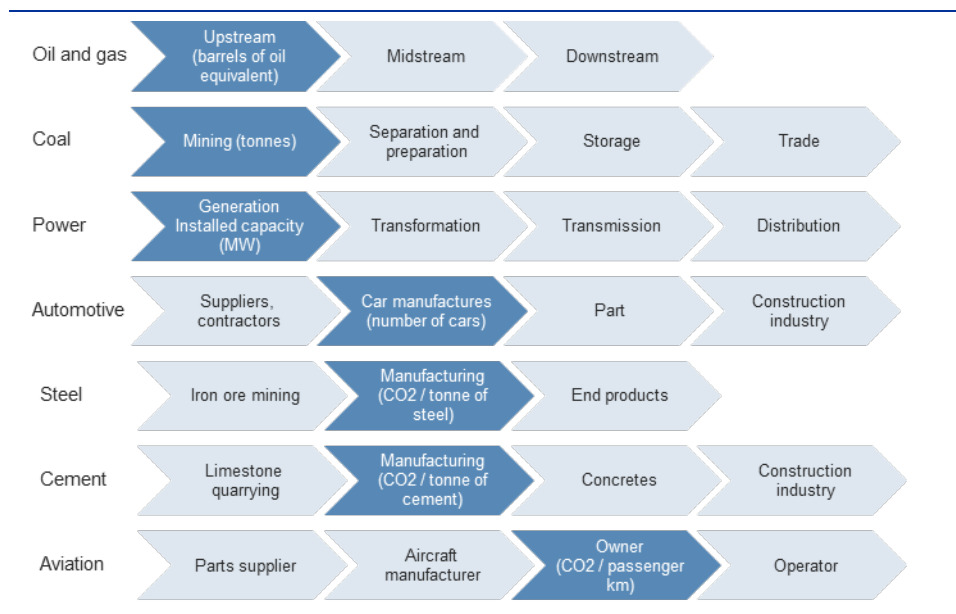
When corporations operate in multiple sectors within the scope of PACTA, the following rule is used to split the loan value between the different sectors. The percentage of total production within the sector that the corporation is producing at both the start and the end of the year (to allow for corporations that fully phase out of a sector or have yet to enter the sector) is calculated. The ratio between the percentages of total production for the multiple sectors is determined and used to distribute the loan amount over the different sectors. Imagine a business producing 10 MW in the power sector and 5,000 tonnes of steel. If total production in the power sector is 10,000 MW and total steel production is 2,500,000 tonnes, the business's share of total sectoral production is 0.1% (10/10,000) for power and 0.4% (5,000/1,250,000) for steel. The ratio of its power production to its steel production is

⁵⁷ See Section 1.11 of the P4B methodology document.

thus 1:4 (0.1:0.4). If the loan to the corporation was €10,000,000, it would be split into €2,000,000 for the power sector and €8,000,000 for the steel sector.

Chart 7.1

Sectors covered in the PACTA methodology and their position in the value chain



Source: RMI.

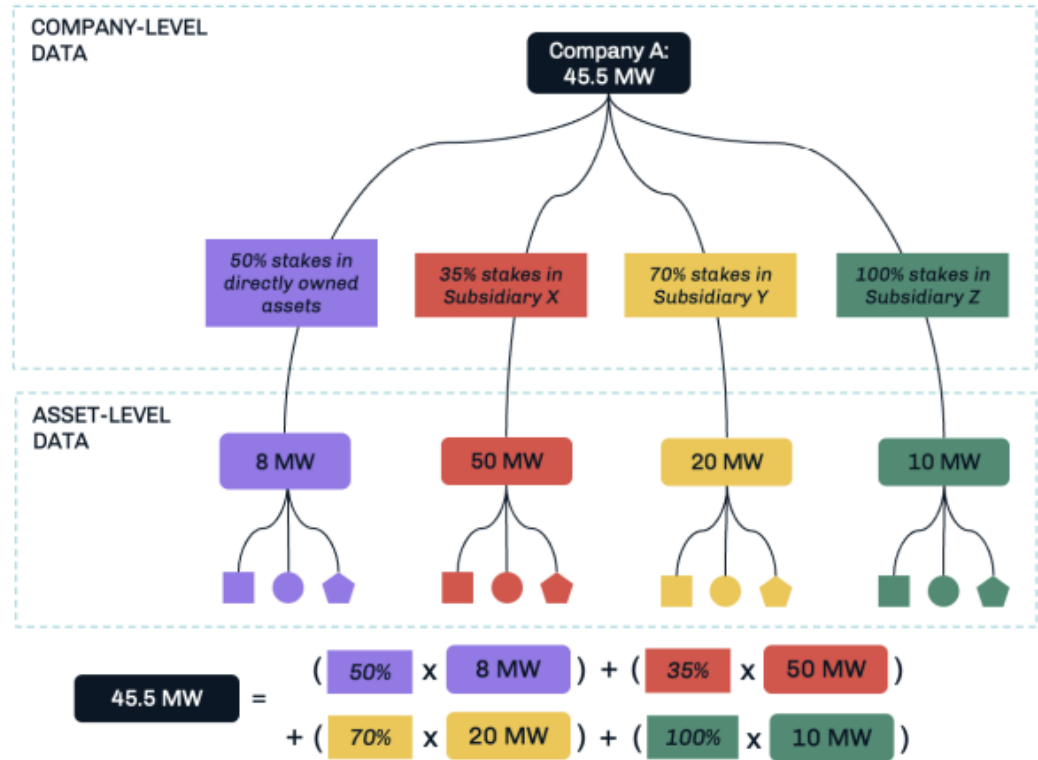
Notes: The dark blue segment in the value chain identifies the point against which alignment is measured in climate change scenarios. The climate indicator/unit of measurement is given in brackets. (Original plot from Figure 4 in the P4B methodology document)

7.2 Equity ownership approach

The assets in the database can be owned in a variety of ways. Often the asset is not held directly by the main entity in the corporation or is held by multiple entities. To handle these situations, assets need to be assigned to their respective owners. This is based on the equity ownership. The assets are assigned to a parent entity on a pro rata basis dependent on the amount of equity the parent entity owns in the asset owner. This is repeated for the parents of the parent companies until an ultimate parent is reached. This process is illustrated in Chart A2.2.

Chart 7.2

Overview of the equity ownership approach for assigning assets to corporations



Source: RMI.

Notes: Original plot from Figure 8 in the P4B methodology document

7.3 Determination of net alignment rates

Determination of net alignment rates

Direction d for technology a in sector b:

$$d_{a,b} = \begin{cases} \text{build - out, for low - carbon technologies} \\ \text{phase - out, for high - carbon technologies} \end{cases}$$

Forward-looking production plan of corporation c for technology a in sector b at time t:

$$p_{a,b,c,d,t}$$

Forward-looking production plan of corporation c in sector b at time t:

$$P_{b,c,t} = \sum_{a \in b} p_{a,b,c,d,t}$$

Scenario-based production value of corporation c for technology a in sector b at time t:

$$S_{a,b,c,d,t}$$

Scenario-based production value of corporation c in sector b at time t:

$$S_{b,c,t} = \sum_{a \in b} S_{a,b,c,d,t}$$

Directional dummy variable for technology a in sector b:

$$D_{direction,a,b} = \begin{cases} 1, & \text{for phase-out technologies} \\ -1, & \text{for build-out technologies} \end{cases}$$

Total technology deviation of corporation c for technology a in sector b at time t:

$$\Delta total_{a,b,c,d,t} = (p_{a,b,c,d,t} - S_{a,b,c,d,t}) \times D_{direction,a,b}$$

Note that the technology deviation will be considered aligned when ≥ 0 and misaligned when < 0 . The directional dummy ensures this is the case for both build-out and phase-out technologies.

Net aggregate corporation alignment:

Total deviation of corporation c in sector b at time t:

$$\Delta total_{b,c,t} = \sum_{a \in b} \Delta total_{a,b,c,d,t}$$

Total scenario value of corporation c in sector b at time t:

$$total_{b,c,t}^{scen} = S_{b,c,t}$$

Alignment measure of corporation c in sector b at time t:

$$z_{b,c,t} = \frac{\Delta total_{b,c,t}}{total_{b,c,t}^{scen}}$$

Calculating the build-out/phase-out alignment measure

Total deviation of corporation c for direction d in sector b at time t:

$$\Delta total_{b,c,d,t} = \sum_{a \in b,d} \Delta total_{a,b,c,d,t}$$

Alignment measure of corporation c for direction d in sector b at time t:

$$z_{b,c,d,t} = \frac{\Delta total_{b,c,d,t}}{total_{b,c,t}^{scen}}$$

Calculating the alignment of emission intensity sectors

For sectors where alignment is calculated using emission intensity metrics (steel and cement) there is no distinction between build-out and phase-out technologies. Hence the equation can be simplified as follows:

Emission intensity based on forward-looking production plan of corporation c in sector b at time t:

$$p_{b,c,t}^*$$

Scenario-based emission intensity value in sector b at time t:

$$s_{b,t}^*$$

Total emission intensity deviation of corporation c in sector b at time t:

$$\Delta total_{b,c,t}^* = p_{b,c,t}^* - s_{b,t}^*$$

Alignment measure of corporation c based on emission intensities in sector b at time t:

$$z_{b,c,t}^* = \frac{\Delta total_{b,c,t}^*}{s_{b,t}^*}$$

For the SDA approach a corporation specific scenario can be constructed and the difference between this adjusted scenario and the projected production would be the net alignment. At the moment most improvements in the steel and cement sector are still incremental in nature, which is harder to capture in forward looking data, therefore the adjusted scenario approach is not yet applied. If the investments to decarbonise the steel and cement sectors increases forward looking data become more applicable and the adjusted scenario approach should be used.

Aggregating the corporation/sector-level metric at the loan book/sector level

The exposure-weighted net (or build-out/phase-out) alignment for a given loan book is calculated as follows:

Loan exposure (debt outstanding) of bank n to corporation c at time t = 0:

$$l_{n,c,t=0}$$

Considering a corporation may be operating in multiple PACTA sectors, a further variable needs to be introduced to account for the sector.

Loan exposure of bank n to corporation c in sector b at time t = 0:

$$l_{n,b,c,t=0}$$

In aggregating the build-out/phase-out values, an approximation of how the loan exposure is split between the build-out/phase-out technologies within a sector is made on the basis of the technology share and is calculated as follows:

$$l_{n,b,c,d,t=0} = l_{n,b,c,t=0} * tech\ share_{b,c,d,t=5}$$

The technology share is calculated on the basis of the corporation's production plan values looking forward five years. This reflects the splitting of the loan by the corporation's planned future technology mix in 2027. This is preferred over taking the technology share at the start of the year, as that may lead to loans not being split if a corporation has no technology capacity at the start of the year but ambitious build-out plans for year 5. Moreover, in order to appear in the asset-based corporate-level dataset, a corporation that plans to build out capacity for a given technology beyond the start of the year has to have committed capital towards it at the start of the year.

Giving the exposure-weighted net alignment metric at the loan book/sector level, as follows:

$$Z_{n,b,t} = \frac{l_{n,b,c,t=0}}{\sum_c l_{n,b,c,t=0}} \times Z_{b,c,t}$$

Where applicable, the exposure-weighted build-out/phase-out alignment metric can be calculated as:

$$Z_{n,b,d,t} = \frac{l_{n,b,c,d,t=0}}{\sum_c l_{n,b,c,d,t=0}} \times Z_{b,c,d,t}$$

This calculates the alignment at the sector level. To be able to easily compare portfolios of different banks, the results should still be aggregated at the portfolio level. This is done by taking an exposure-weighted average of all the sector deviation rates, after the sector deviation rates are normalised for each of the sectors, as the deviation in different sectors have significant differences.

8 Annex 3: Scenario supplement

Two transition scenario sets have been selected. These provide sector decarbonisation pathways that are used within the PACTA methodology to assess climate alignment for the euro area banking sector – see the 2022 edition of the International Energy Agency's (IEA's) World Energy Outlook (WEO)⁵⁸ and the 2022 edition of the European Commission's Joint Research Centre's (JRC's) Global Energy and Climate Outlook (GECO)⁵⁹. Each scenario set consists of three scenarios which, based on the modelling choices, are divided by the climate modelling community into two distinct categories:

IEA WEO 2022 scenario set

The WEO provides insight into the evolution of economy-wide energy use, providing in the process sectoral decarbonisation pathways that are granular enough to be used for PACTA climate alignment measurements for the fossil fuel, power generation, automotive, steel and cement sectors. It is based on a combination of the World Energy Model (WEM) and the Energy Technology Perspectives (ETP) model. It is included as an integrated assessment model (IAM) in the Integrated Assessment Modelling Consortium (IAMC) database in support of Intergovernmental Panel on Climate Change (IPCC) assessments.⁶⁰

The 2022 edition of the WEO has been updated to take into account the impact of the energy crisis triggered by the Russian invasion of Ukraine on policy commitments and pledges, energy prices and the pace of technology phase-down and build-out deployment, which can already be seen to be significant, even in the baseline scenario (Stated Policies Scenario – STEPS).

The IEA's Net Zero Emissions by 2050 (NZE) scenario extends the Sustainable Development Scenario (SDS) in order to create a normative scenario that is modelled to achieve net-zero emissions by 2050. The scenario assumes no overshoot by 2050 (1.5°C). If all the targets are achieved as set out in this scenario, the modelling indicates a 66% probability of limiting global temperature rise to 1.5°C by 2100.

The NZE scenario is a response to the increasing focus by governments and industry on commitments to reach net-zero emissions earlier, combined with the aim of limiting climate change to the main Paris Agreement objective of 1.5°C above pre-industrial levels. Its principal assumptions are that technology uptake will be driven

⁵⁸ IEA, *World Energy Outlook 2022*, November 2022

⁵⁹ Keramidas, K., Fosse, F., Diaz Rincon, A., Dowling, P., Garaffa, R., Ordonez, J., Russ, P., Schade, B., Schmitz, A., Soria Ramirez, A., Vandyck, T., Weitzel, M., *Global Energy and Climate Outlook 2022: Energy trade in a decarbonised world*, Publications Office of the European Union, Luxembourg, 2022.

⁶⁰ The IAMC is hosted by the International Institute for Applied Systems Analysis (IIASA).

by cost and market conditions, that there is international cooperation to achieve the climate goal and that there is an orderly transition across the energy sector.

Carbon pricing is assumed to be introduced differentially across regions, with lower levels in emerging markets and with some countries opting to mainly pursue policies instead of carbon pricing. This reflects the high proportion of nationally determined contributions (NDCs) that include plans to introduce market pricing mechanisms and plans announced by major emerging market economies such as Indonesia and South Africa. Lower initial pricing in emerging market and developing economies is based on the assumption that they will also pursue policies to use renewable sources for the expansion of their energy systems and also reflects experience with the evolution of price levels in the market-based pricing systems of advanced economies. The NZE scenario differs from the JRC's GECO 1.5°C scenario in that the carbon price does not represent the marginal cost of abatement for emissions, so other measures and the evolution of fossil fuel prices are assumed to act in conjunction with carbon pricing to bring solutions to the market.

In particular, the NZE scenario models the actions needed in the critical period to 2030 in order to be on track to achieve net-zero emissions by 2050, including the need to significantly increase the build-out of renewable energy coupled with the wider deployment of low-carbon technologies across sectors as a means of reducing fossil fuel consumption. In contrast to the estimated USD 2 trillion investment in technology by 2030 to achieve the STEPS scenario, the NZE scenario would require a doubling of this investment to USD 4 trillion by 2030. By 2030 the ratio of spending on low-carbon technology to fossil fuels would need to be 5 to 1, meaning that for every €1 invested in fossil fuel technologies, €5 would have to be spent on low-carbon technologies. Linked to these assumptions, the scenario also explores the resulting prospects for new fossil fuel exploitation from 2021 onwards as a rapid drop in demand takes place. The modelling is designed to minimise asset stranding across sectors, with asset replacement achieved in the most efficient way possible.

JRC GECO 2022 scenario set

The GECO scenario set is published as part of the JRC's annual Global Energy and Climate Outlook (GECO), which is produced for the European Commission's Directorate-General for Climate Action (DG CLIMA). The scenario set combines the use of a global energy model (Prospective Outlook for the Long-Term Energy System – POLES) and a global economic model (GEM-E3). It provides pathways to support PACTA alignment measurements for the fossil fuel, power generation, automotive, steel and aviation sectors. It is included as an IAM in the IAMC database in support of IPCC assessments. The 2022 edition of GECO has been updated to take into account the impact of the energy crisis triggered by the Russian invasion of Ukraine on policy commitments and pledges, energy prices and the pace of technology phase-down and build-out deployment, which can already be seen to be significant, even in the current baseline exploratory scenario.

The 1.5°C (GECO-1.5) scenario provides an overall pathway to achieving 1.5°C. It is constructed on the basis of the reference scenario. The scenario assumes a low overshoot by 2050 (1.7°C) with global net-zero GHG emissions reached after 2060. If all the targets are achieved as set out in this scenario, the modelling indicates a 50% probability of limiting the global temperature rise to 1.5°C by 2100. The reference scenario it is built upon takes into consideration EU policies such as Fit for 55 (2021) and the RePowerEU Plan (2022), as well as mechanisms such as the Emissions Trading System.

The main policy and economic driver of ambition in the modelling is the application of a single global carbon price from 2021 onwards. Technologically it is predicated on an accelerated deployment of renewable energy, continuous improvements in energy efficiency, the widespread electrification of energy use and, in certain sectors, the use of hydrogen and derivative fuels. The scenario is designed to represent an “economically efficient” pathway to 1.5°C because it assumes that the introduction of technologies is driven by the carbon price and by where the marginal cost of abatement is lowest.

Although the 1.5°C scenario has limited reliance on carbon capture and storage technologies, land-based emissions sequestration (specified as land use, land use change and forestry) plays an important role after 2030. No specific reference is made in the documentation to the role of behavioural change.

Exploratory and normative scenario driving forces and modelling

In order to switch certain sectors to a net-zero scenario, large changes are required. The 2010 data show that for some sectors these changes have already started. Total installed solar and wind power increased by a factor of six between 2010 and 2020 and is expected to increase by a factor of five between 2020 and 2030 and then to double in the subsequent decade. For electric cars the rate of change is even higher, from almost no electric car production in 2010 to a few million in 2020, almost 60 million in 2030 and more than doubling in the decade after that. As certain technologies are built out over the years, others will need to be phased out. Oil extraction, for instance, should reduce from 28,000 million barrels in 2020 to less than half that in 2040 and almost half again in 2050. This illustrates that, as certain technologies are built out, others will be phased out, possibly leading to stranded assets.

In the EU, the 2020 GHG emissions reduction targets (set in 2008) were achieved and even exceeded. The 2020 target was an emissions reduction of 20% compared to 1990 levels. The actual emissions reduction achieved in 2020 was over 30%, well above the target. The European Environment Agency therefore concluded that the fundamental aspects of the transition towards climate neutrality were in place.⁶¹

The modelling choices on which the scenarios are constructed are built up primarily from a combination of reference data sources (e.g. socioeconomic projections),

⁶¹ European Environment Agency, “[Trends and projections in Europe 2022](#)”, 2022.

government policies and pledges, economic assumptions and expert judgements. What follows is a non-exhaustive list of the main modelling choices identified from the IEA WEO 2022⁶² and JRC GECO 2022⁶³ documentation:

- **Remaining carbon budget management:** The profile and timing of the trajectory for emissions reductions in turn influences the probability of achieving a given level of climate change mitigation. Early action in the time window to 2030 is essential in order to maintain the probability at or above 50%. Modelling choices include whether there is any early overshoot of the temperature goal and when net-zero emissions are anticipated to be achieved.
- **Socioeconomic projections:** Existing exogenous macroeconomic projections for global and regional population change and gross domestic product (GDP) are used. The choice of projections, or trajectories, may also reflect the choice of a specific narrative about future social change or economic development pathways. In the more ambitious scenarios, the impact on GDP of investment in low-carbon technology development is modelled.
- **Policy commitments:** The extent to which the implementation of specific policies and associated regulatory frameworks, including, for example, targets and time horizons for technology phase-out or improvements in performance, will drive sector technology transitions.
- **Policy pledges:** In contrast to firm policy commitments with targets backed by policy and regulation, medium to long-term pledges are usually not fully transposed into a detailed regulatory framework for implementation. This means that their achievement is subject to greater uncertainty, so their implementation is reflected in scenarios that add an additional layer of ambition onto existing policies and targets.
- **Disruptive events:** The potential impact of sudden disruptive events such as the coronavirus (COVID-19) pandemic and Russia's invasion of Ukraine have been factored into both IEA and JRC scenario modelling, taking into consideration the uncertainty around their longer-term impact.
- **Carbon pricing:** Global and regional assumptions as to how markets for carbon trading may be extended and the evolution of the associated price of carbon. Assumptions of carbon price evolution are used, for example, to drive increased ambition in the 1.5°C scenarios.
- **Technology learning and adoption:** Expert judgements as to the commercial status and market adoption trajectory of different technologies and the role they will play in the decarbonisation of specific sectors. Particularly important to the achievement of the 1.5°C scenario climate

⁶² IEA, op. cit.

⁶³ Keramidas, K. et al., op. cit.

goals are assumptions relating to the commercialisation and deployment of carbon capture, utilisation and storage (CCUS) technologies.

- **Behavioural change:** A sensitivity analysis is introduced into the modelling of the IEA's NZE scenario in order to explore the potential implications of long-term changes in consumer behaviour, for example in relation to private mobility and the use of energy in the home.

All these choices are associated with levels of uncertainty about the future and, particularly in the case of the 1.5°C scenarios, this uncertainty is greater because of a quantitative increase in the level of ambition required and, consequently, new assumptions about, for example, technology deployment.

Table 8.1

Comparison of the main driving forces and modelling choices underpinning the two normative 1.5°C decarbonisation pathways

The main scenario modelling choices and assumptions		IEA Net Zero by 2050 scenario	JRC GECO 2022 - 1.5°C scenario
Remaining carbon budget management	Average global temperature target in 2100	1.4°C	1.5°C
	Probability of achieving warming goal by 2100	50%	50%
	Overshoot before 2050 (temperature reached)	No overshoot (1.5°C)	Low overshoot (1.7°C)
	Annual emissions in 2030	21 Gt CO ₂	39.1 GtCO ₂
	Net zero timing ¹	Net zero in 2050	Net zero by 2065
	Cumulative global CO ₂ budget	460 GtCO ₂ (2020-2100)	500 GtCO ₂ (2020-2100)
Socio-economic projections	Global population	8.5 billion (2030) 9.7 billion (2050) ⁵	8.5 billion (2030) 9.4 billion (2050) ⁶
	Compound GDP growth	2,7% (2021 to 2030) 2,3% (2030 to 2050)	Not provided
	GDP per capita (k \$)	21,6 (2030) 32,6 (2050) ⁷	19,6 (2030) 29,2 (2050) ⁸
	Carbon price geography	Price variation between advanced, emerging and developing economies	Single global price, sigmoid curve with 2040 inflection
	Direct market CO ₂ price ²	25-140\$ tCO ₂ (2030) 180-250\$/tCO ₂ (2050)	Not provided
Technology learning and adoption	Main assumptions on technology maturity	50-60% of required CO ₂ reductions are from technologies currently at demonstration or prototype stage.	A technology learning-curve approach is applied.
	Sectors or technologies for which a sensitivity analysis is carried out	Behavioural changes, bioenergy, CCUS for fossil fuels	Not provided
	Primary Energy demand	-9,4% (2021 to 2030) -15,4% (2030 to 2050)	-3,9% (2020 to 2030) -0,2% (2030 to 2050)
	Electricity production	+33,1% (2021 to 2030) +194,1% (2030 to 2050)	+31,8% (2020 to 2030) +217,5% (2030 to 2050)
	The role of carbon capture utilization and storage	7.6 Gt CO ₂ in 2050	4.6 Gt CO ₂ in 2050
	The role of bioenergy with carbon capture and storage (BECCS) ³	1.1 Gt CO ₂ in 2050	BECCS is assumed to play an important role in some countries.
	Use of nature-based solutions as offsets ⁴	No offsets from outside the energy system are assumed.	Assumes some offsets from Land Use, land use Change and Forestry (LULUCF)

Sources: IEA, JRC, RMI.

Notes: 1. Net zero carbon dioxide (CO₂) emissions are achieved when anthropogenic CO₂ emissions are balanced globally by natural and anthropogenic CO₂ removals over a specified period. Net zero CO₂ emissions are also referred to as carbon neutrality. 2. Direct pricing is in applied in proportion to the emissions from a specific activity. The impact of direct CO₂ pricing is considered alongside other policy measures in the IEA's modelling so does represent the marginal cost of abatement. 3. Bioenergy with carbon capture and storage (BECCS) is the combination of heat and power generation using bioenergy sources such as biomass with the use of technologies to capture and store the CO₂ emissions from combustion. 4. Nature-based solutions are carbon sinks of natural origin, such as forests or plantations, that are conserved, restored or better managed in order to achieve a net reduction in CO₂ emissions. 5. UN DESA (2019) 6. European Commission (2022), IMF (2022), OECD (2018) 7. Oxford Economics (2022) and IMF (2022) 8. Eurostat (2021), JRC-IASA (2018)

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