Analysis

Towards more sustainable lending

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DeNederlandscheBank
EUROSYSTEEM

Towards more sustainable lending

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1 Introduction

Climate change is having negative repercussions that are increasing in frequency and severity, necessitating the transition to a sustainable economy. To this end, 196 countries signed the Paris Climate Agreement, committing themselves to limit global warming to well below 2°C, with a preference for 1.5°C. Achieving this will require a transition to a sustainable economy and a reduction in carbon emissions. On the one hand, this means reducing carbon-intensive activities and the production of goods that emit a lot of carbon dioxide, e.g. cars with internal combustion engines. On the other hand, more low-carbon alternatives are needed, for example electric vehicles.

Transitioning to a sustainable economy presents banks with transition risks. In this study, we analyse the extent of these transition risks by identifying the deviation of companies in loan portfolios of Dutch banks from the transition path required to meet climate goals. The Paris Climate Agreement implies significant changes for society, the economy and the financial sector. If companies financed by banks lag behind the required transition path[1], they may find themselves squeezed by tighter government policies, legal rulings and changing consumer preferences, among other factors. This could result in a write-down of these companies' assets and thus lead to transition risks for banks. This study uses the Paris Agreement Capital Transition Assessment (PACTA)[2] to identify where the credit portfolios of Dutch banks are along the transition path required to meet the goals of the UN Paris Climate Agreement.[3]

We conclude that banks are exposed to transition risks because companies in their loan portfolios are not switching to low-carbon alternatives quickly enough. This conclusion is in line with the findings in the study Balancing sustainability, in which the PACTA method was applied to the investment portfolios of Dutch pension funds and insurers. That study reveals that the activities of companies in the portfolios of pension funds and insurers are lagging behind the required transition path and that they face an increased risk of stranded assets[4]. The results of both studies underline the importance of the Financial Sector Climate Commitment, in which a large number of Dutch financial institutions have agreed to explain what actions they are taking to help fulfil the Paris Agreement starting in 2022.

De Nederlandsche Bank (DNB) supervises adequate management of sustainability risks by financial institutions. The initial steps have already been taken to integrate these transition risks into supervisory practice. For example, the ECB published its supervisory expectations for how banks should address such climate and environmental risks, and DNB published a Good Practice for banks with guidance on how to integrate climate risks into banks' governance, risk management and reporting.[5] In addition, the European Commission published a proposal last year to set standards in the Capital Requirements Directive (CRD) and Capital Requirements Regulation (CRR) for how sustainability risks should be integrated into banks' risk management policies and procedures and in the prudential supervision of banks.[6] DNB advocates at both the global level (in the Basel Committee on Banking Supervision, the international standard-setter for banking regulation) and the European

[1] This analysis uses the International Energy Agency's Net Zero Emissions by 2050 Scenario as the transition path. See Box 2 for more information on this scenario.
[2] PACTA is an open source tool developed by the 2° Investment Initiative and transferred to the Rocky Mountain Institute in June 2022 [link]. See Box I and Appendix III for more information on this tool.
[3] Other methods are also available and financial institutions are free to choose which method they use.
[4] Stranded assets are defined as assets that have suffered unexpected or premature depreciation, write-downs or conversion to liabilities as a result of, for example, new climate and environmental regulations (DNB, 2021).
[5] The ECB uses its guide on climate-related and environmental risks in its supervisory dialogue with significant institutions under its direct supervision. DNB also uses the ECB guide in its supervision of less significant institutions. Our use of the ECB Guide is complementary to, and in line with, our Good Practices document.
[6] The EC's proposal for CRR/CRD is currently being negotiated in the European Council and the European Parliament. Following a final agreement on the new CRR/CRD package by all EU legislators, these requirements could come into force as of January 2025.

level (at the European Banking Authority, the EU banking regulator) for the appropriate treatment of climate risks in the capital framework. In particular, DNB is strongly in favour of setting concentration limits to address climate risks.

2 Data & Method

The PACTA methodology can be used for corporate loans extended by banks for power generation, oil, gas and coal extraction, automobile, steel and cement production and to airlines. Together, these sectors account for the vast majority of all carbon emissions.[7] Figure 1 shows the size of PACTA sectors in the loan portfolios of Dutch banks and the segment of the portfolio that can be linked[8] to a dataset produced by Asset Resolution which contains information on climate-related financial assets. The information in the dataset is on the current production and future production (capacity) of companies active in the PACTA sectors. For the automotive sector the dataset includes both the number of electric cars a company currently produces and the number it plans to produce in the future. For the power sector, it contains information on the current and future capacity of coal-fired power plants and oil fields owned by companies.

Box 1 PACTA

The PACTA methodology examines transition risks in banks' loan portfolios. Companies use loans extended by banks to invest in projects. By looking at the activities undertaken by these companies, and thus indirectly at the activities banks finance, it is possible to determine whether the companies in banks' loan portfolios are aligned with the Paris Climate Agreement goals. This is done by comparing current and projected production (capacity) with a transition path needed to meet the climate agreement goals. The various production plans and alignment targets of all companies are aggregated based on their share in banks' loan portfolios. This aggregate picture provides an indication of the transition risks banks face.

The methodology looks at physical assets that contribute to global warming. It examines companies' plans for the coming years; for example, whether they intend to invest more in renewable power generation or build more coal-fired power plants. It uses asset-level data points to do so. In the automotive sector, for instance, data points include car manufacturers' own production plans for new cars, including electric vehicles. The PACTA tool then shows the extent to which these production targets are in alignment with the production level required under the transition scenario.

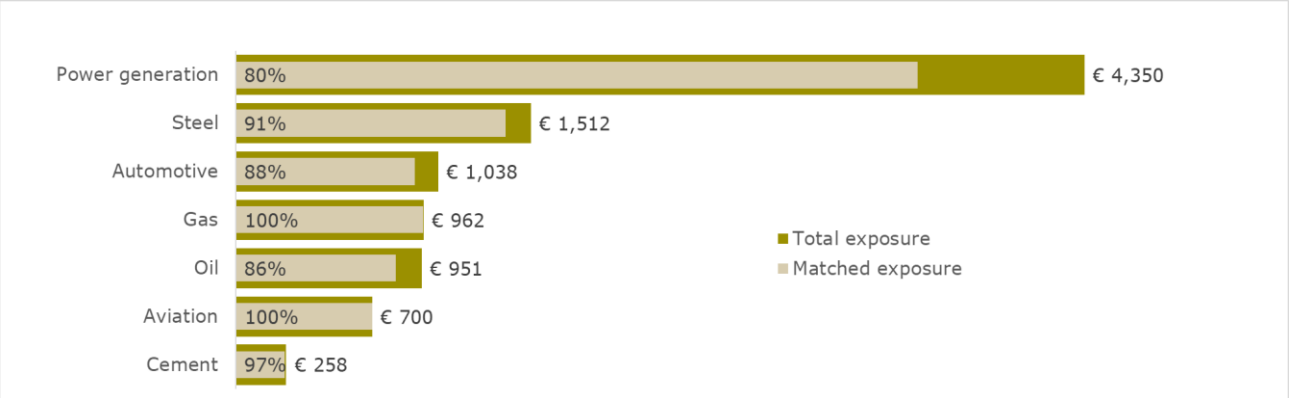
The PACTA methodology only includes those parts of the value chain where decarbonisation efforts are required to bring the entire value chain into alignment with the goals of the Paris Climate Agreement. Thus, for the oil sector, it only covers extraction along with power generation and consumption in the transport sector. It does not cover oil refining, transport and sale. See Appendix III for a more detailed description of the PACTA methodology[9]

Dutch banks' exposure to PACTA sectors totals €9.8 billion, which equates to 2.5% of the €391 billion in loans to non-financial corporations.[10] Although this exposure relates to only a small proportion of banks' total loan portfolios, the analysis provides a reliable indication of the transition risks banks face, as it focuses on business activities with high carbon emissions and in which the transition needs to take place. At €4.4 billion, power generation represents the largest exposure to PACTA sectors in Dutch banks' loan portfolios. Of that amount, €3.5 billion can be linked to Asset Resolution's dataset of corporate production data. Around €1.5 billion worth of loans have been extended to companies involved in steel production and €1 billion to companies in the automotive, oil & gas and aviation sectors. Exposure to the cement sector is relatively minor at a quarter of a

[7] If end-use is included alongside extraction and production, then these sectors account for three quarters of carbon emissions. See [link] [link].
[8] Some of the companies in banks' loan portfolios are not linked to PACTA data. Reasons for this may be that the company in question does not appear in the dataset or that it cannot be automatically linked to the data and the exposure is too small (< €10,000,000) to manually check whether the company appears in the dataset.
[9] In addition to Appendix III, the PACTA for Banks Methodology Document [link] can be consulted for more information.
[10] Only the banks that report AnaCredit are included [link]. The majority of loans are for activities with low carbon emissions such as real estate, administrative and support services, wholesale, retail and professional services, and science and technology.

billion euro in outstanding loans. In total, more than 85% of the loan portfolio can be linked to Asset Resolution's dataset. This makes it possible to reliably measure the extent to which Dutch banks' loan portfolios are in line with the Paris Climate Agreement goals. The coal extraction sector is not reflected in the analysis as Dutch banks' exposure to this sector is very limited (at just €5 million) and thus cannot be linked to the Asset Resolution dataset. The analysis does include the use of coal in power generation, however.

Figure 1 Exposure of banks' loan portfolios to PACTA sectors



Total exposure in banks' loan portfolios to PACTA sectors at the end of 2021 (dark bar) and the proportion of those portfolios that we were able to link to the Asset Resolution dataset (lighter bar). Amounts in EUR millions.

Source: DNB.

3 Results

The extent to which the activities of companies in the loan portfolios of banks deviate from the transition path is an indication for the transition risks that the banks face. Low-carbon technologies are available for the power, automotive and fossil fuels sectors. The transition scenario therefore prescribes a shift to low-carbon production in these sectors. For power generation, this means transitioning from coal and oil to renewable energy sources. The automotive sector must move away from petrol and diesel engines in favour of fully electric and hybrid cars. Low-carbon alternatives are not (yet) widely available for the aviation sector or the steel and cement industries. We therefore apply a different methodology to these sectors that looks at carbon intensity. The results for these sectors show that carbon intensity must decrease by around 15-20%; see Appendix II. Box 2 explains the transition scenarios used.

Transition risks in Dutch banks' loan portfolios will increase sharply in the years ahead. Table 1 summarises the results of the PACTA analysis. The analysis provides insight into the extent to which the companies in the loan portfolios of Dutch banks operate in line with the transition scenario, making use of two different measures: technology mix and production trajectory. Different technologies are used in the power and automotive sectors. Both carbon-intensive technologies, such as oil- and coal-fired power generation, and low-carbon technologies, such hydropower, solar or wind, are available. The technology mix shows the ratio of different technologies within a sector and thus reflects whether the transition from carbon-intensive to low-carbon technologies is proceeding at an appropriate pace. If the technology mix deviates from the transition scenario, this could be due to an insufficient phase-out of carbon-intensive activities or a lag in the increase in low-carbon alternatives. We therefore also look at the production trajectory, which reflects how much production of a given technology is available and needed in the future, and measures to what extent the production trajectory of a technology, both carbon-intensive and low-carbon, is aligned with the climate scenarios. Considering both measures, we conclude that companies in the loan portfolios of Dutch banks in almost all carbon-intensive sectors are not adapting quickly enough. Only in the natural gas production sector companies are on average adapting quicker than the transition scenario prescribes. The results are explained later in this section.

Table 1 Summary of results

	Power generation	Automotive manufacturing	Oil	Gas
Technology mix	✗	✗		
Production trajectory	✗	✗	✗	✓

A red x indicates that the companies in the loan portfolios of Dutch banks are lagging behind the transition scenario. A green tick indicates that these companies are aligned with the scenario or that they are even ahead of the transition path.

Sources: Asset Resolution, PACTA, DNB.

Box 2 Transition scenario

To assess whether the activities of companies in banks' loan portfolios are in alignment with the Paris Climate Agreement goals, we use the Net Zero Emissions by 2050 Scenario (NZE) developed by the International Energy Agency (IAE).[11] In this scenario, there is a 50% probability that global temperatures will rise by no more than 1.5°C by 2050. This is in line with the objective of the sixth IPCC report. According to the NZE, there will be net zero CO_2 emissions worldwide by 2050. To achieve this goal, we will have to use less energy and generate energy differently than we do today. A rapid increase in wind and solar power generation is needed, and the share of electric cars in global car sales will have to rise from around 5% in 2020 to 60% by 2030.

Appendix I also shows the results for the IEA's Sustainable Development Scenario (SDS). Under this scenario there is a 50% probability of a 1.7°C global temperature rise by 2050. The two scenarios show similar results for most technologies.

Power generation

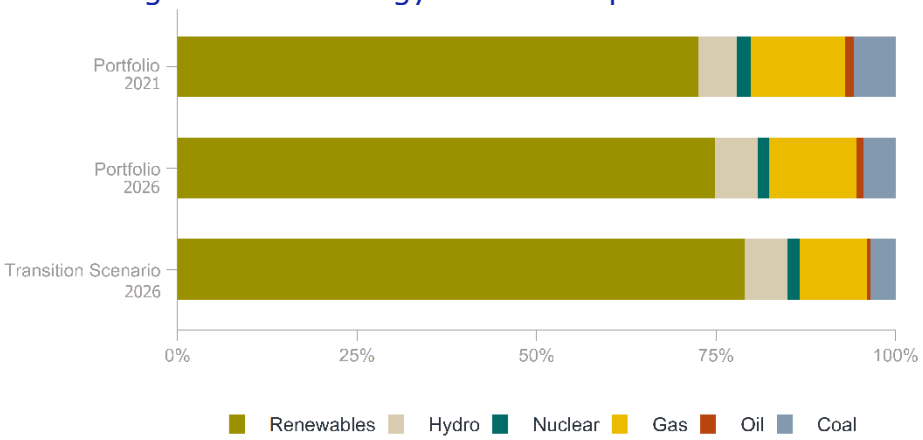
Transition risks related to loans to power companies will increase in the years ahead. Using two different measures, technology mix and production volume trajectory, we conclude that gas, oil and coal-fired power generation capacity is not decreasing fast enough and that power generation from renewable sources is not increasing fast enough to meet the Paris Climate Agreement goals.

The technology mix of the power sector in banks' loan portfolios is lagging behind the 2026 alignment targets. Figure 2 shows the technology mix in banks' power sector loan portfolios in 2021 (top bar) and in 2026 (middle bar) based on the five-year plans of the companies receiving loans at the end of 2021. The bottom bar shows what the 2026 ratio should be to meet the transition scenario. The difference between the middle and bottom bars reveals the extent to which the technology mix in banks' loan portfolios deviates from the requirements of the transition scenario and is thus indicative of transition risks. For this analysis, renewable energy includes wind and solar power. Renewable energy accounted for about 70% of the technology mix at the end of 2021. This is because investments are mainly made in renewable power generation and to a lesser extent in fossil power generation.[12] Although renewable energy forms a large part of the technology mix and its share will expand in the coming years, the expansion by 2026 will fall short of the level required by the transition scenario by 5 percentage points. In contrast, the increase in hydropower generation deviates less from the transition scenario, as this technology needs to increase by only a fraction compared to renewable energy. In fossil power generation, capacity remains greater than the transition scenario prescribes, especially for gas and coal.

[11] This analysis uses the 2021 NZE. It is currently not yet possible to apply the PACTA method to the 2022 scenario. A scenario needs to be translated into PACTA transition paths. Companies must also adapt their plans to the changing situation. Once they have done so, this information will also have to be updated in the Asset Resolution database. This is why the scenario as applied often lags behind the most recently published scenario. The new NZE calls for less power to be generated from fossil fuels by 2050. However, the path to 2050 has also been altered slightly, as the ratio between different fossil sources for power generation has changed (see footnote 13). As a result, risks may be distributed differently within a sector. Nevertheless, the conclusion remains that banks face transition risk through their loan portfolios unless companies have fully adapted in the meantime.

[12] In 2018, investments in wind and solar power accounted for 65% of total investments in wind, solar, fossil and nuclear power [link].

Figure 2 Technology mix of the power sector



The bars indicate the share of different power generation technologies in the total power generation capacity of companies in banks' loan portfolios. The top bar shows the current situation (2021). The middle bar shows what the situation will be in 2026 according to the plans of the companies that have received loans. The bottom bar shows what the technology mix should be according to the transition scenario.

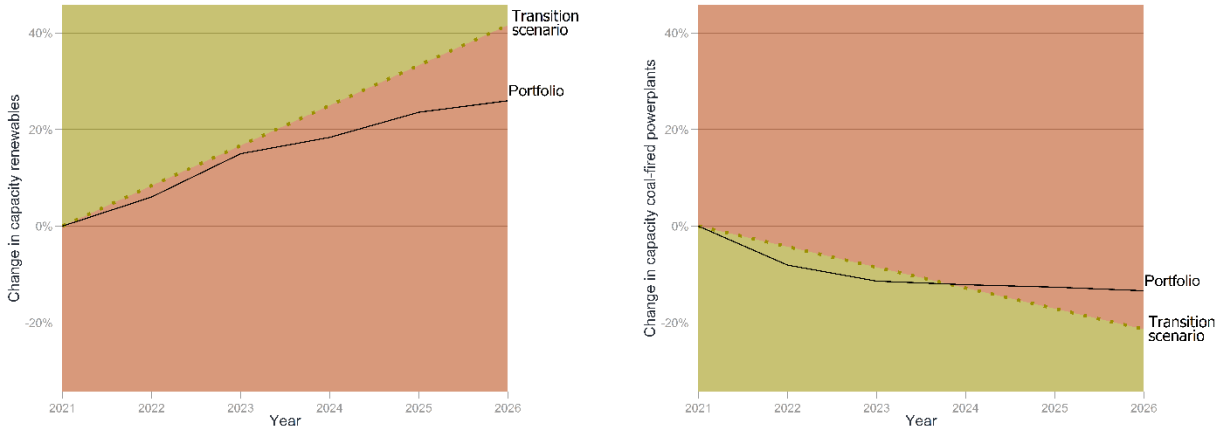
Sources: Asset Resolution, PACTA, DNB.

Coal-fired power generation is not decreasing as much as called for to meet the climate agreement goals. Figure 2 does not show whether the excessive share of coal-fired power generation in the technology mix is the result of a lag in closures of coal-fired power plants or a lag in the growth of renewables. We therefore look not only at the ratio of technologies, but also at the production trajectory per technology. Figures 3a and 3b show projections for the production capacity of companies to which Dutch banks have extended loans – the solid line – compared to the transition scenario – the dotted line. The transition scenario in Figure 3a shows a downward trend, as coal-fired power generation needs to be phased out. The probability of stranded assets increases when the projection of the production moves above the dotted line – and thus into the red area. Until 2024, the drop in production is greater than the transition scenario requires. The phase-out of coal-fired power plants subsequently falters. Oil-fired power generation is not declining fast enough either.[13] Specifically for the power sector, it is important to note (also in view of current events in this sector as a result of the war in Ukraine) that PACTA looks at production *capacity* rather than production *volume*. Box 3 discusses the implications of this difference.

Renewable energy capacity will not increase fast enough in the years ahead. Figure 3b is the equivalent of Figure 3a, but for renewable energy. Companies in banks' loan portfolios intend to increase their capacity to generate power from renewable sources, according to their plans. Until 2023, this increase is roughly in line with what the scenario prescribes (the solid line is roughly equal to the dotted line). The increase subsequently becomes less steep and the difference with the scenario becomes more pronounced. Additional investment will therefore be needed to maintain the transition path after 2023. The same applies to hydroelectric and nuclear power generation.[14]

[13] See Appendix I.
[14] See Appendix I.

Figures 3a and 3b Production capacity of coal-fired power plants and renewables



The solid line represents the projection of the production capacity of companies in banks' loan portfolios and the dotted line between the green (lighter) and red (darker) area represents the production path required to limit global warming to 1.5°C by 2050. If the solid line moves into the red area, the production capacity projection of companies in banks' loan portfolios is insufficient to meet the climate agreement goals. If this line is in the green area, companies are adapting faster than the transition scenario requires.

Sources: Asset Resolution, PACTA, DNB.

Box 3 Production capacity rather than production volume

For the power sector, PACTA examines production capacity rather than production volume. One reason for this is that more reliable data is available on installed capacity in the power sector for the coming years than for actual production volumes. Permits issued enable reliable projections of future production capacity. Sectoral shocks, such as sudden changes in power policy, thus have less effect.

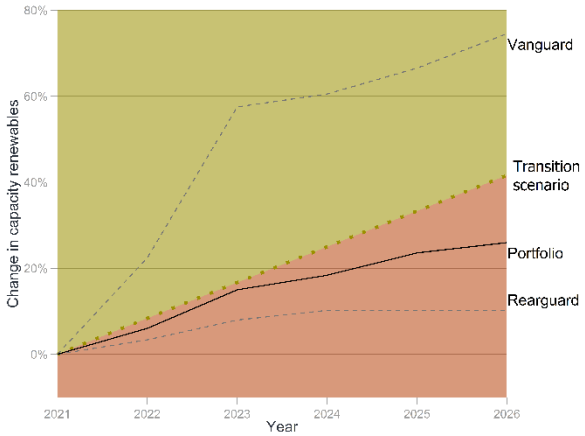
Before Russia's invasion of Ukraine, the production volume of coal-fired power plants was only 35% of capacity, but the invasion has induced many countries to increase the production volumes of their coal-fired power plants and to use less natural gas to generate electricity. This means coal can be used to generate more electricity without installing additional generation capacity. Figure 3a therefore does not change as a result. New scenarios take these changes into account, as well as additional carbon emissions from coal-fired power plants in the short term. Investment in the expansion of fossil power plants is therefore associated with high transition risk.[15] This underlines the importance of repeating this analysis in the future.

Transition risks vary from bank to bank, meaning it is important to conduct this analysis for companies in individual banks' loan portfolios. Transition risks increase when companies' plans lag behind a transition scenario while policy is aimed at compliance with this scenario. In our analysis, we look at the *aggregated* picture for the loan portfolios of *all* Dutch banks. The results per bank vary widely, however. To illustrate this, we present Figure 3a again, but with additional dotted lines representing a bank with a loan

[15] According to the updated NZE scenario, less power will have to be reprocessed from fossil fuels in 2050 than according to the NZE scenario from 2021 that forms the basis for this analysis. Also, according to the updated scenario, the mix of fossil sources for power generation is different. In the most recent NZE scenario, power generation from coal will have to decrease to a lesser extent by 2030 than according to the 2021 scenario, while power generation from gas will have to decrease more. See [link] page 128 in the updated report and [link] page 58 in the 2021 report.

portfolio in which the increase in renewable energy production capacity is most ahead of the transition scenario, and a bank with a loan portfolio in which capacity is lagging most seriously behind. See Figure 4.[16] The large differences make it imperative for banks to perform such analyses for the different sectors and companies in their loan portfolios.

Figure 4 Renewable energy production capacity



The solid line represents the projection of the production capacity of companies in banks' loan portfolios and the dotted line between the green (lighter) and red (darker) area represents the production path required to limit global warming to 1.5°C by 2050. If the solid line moves into the red area, the production capacity projection of companies in banks' loan portfolios is insufficient to meet the climate agreement goals. If this line is in the green area, companies are adapting faster than the transition scenario requires. The upper dotted line represents the portfolio of a Dutch bank that is most ahead along the transition path and thus well into the green area. The lower dotted line represents the portfolio of a Dutch bank where growth in renewable energy lags the most behind the transition path.

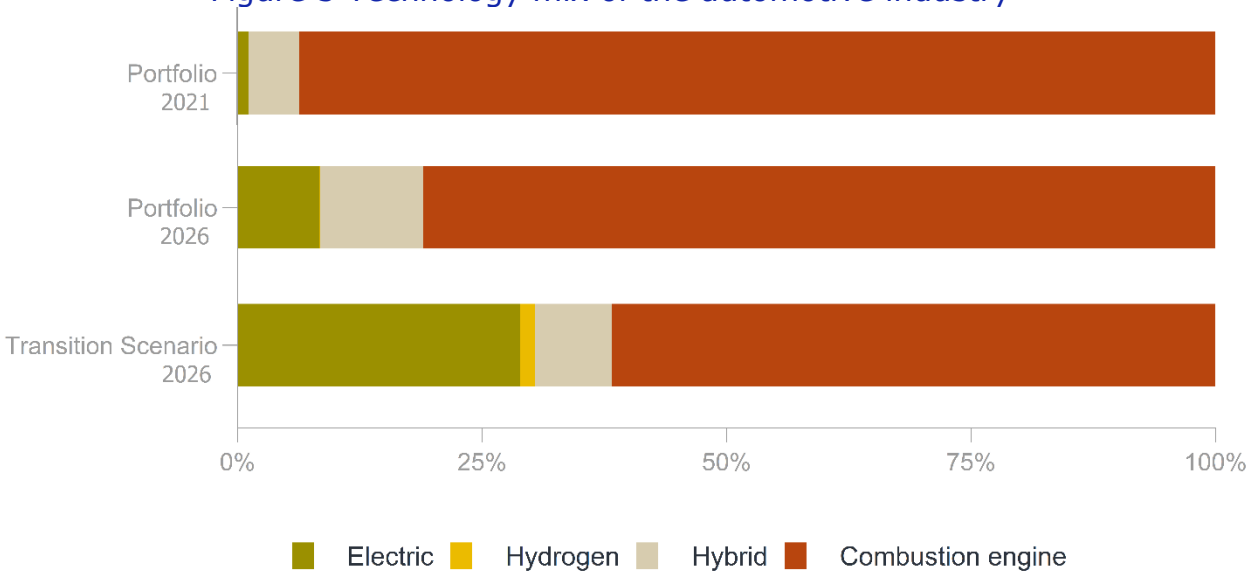
Sources: Asset Resolution, PACTA, DNB.

Automotive

Transition risks for loans extended to the automotive industry are increasing. This is reflected in both technology mix and production volume. The technology mix determines the production ratio for different powertrain technologies: electric, hydrogen, plug-in hybrid and internal combustion engine. Figure 5 shows that the technology mix for the automotive industry in 2026 deviates significantly from the transition scenario: the share of cars produced with internal combustion engines should fall to 65% by 2026, while the share is expected to be around 80%. The share of electric cars falls more than 15 percentage points short of what is needed to meet climate targets. In contrast, the transition to plug-in hybrids is more rapid than the scenario calls for.

[16] The results for the best and worst performing banks for the remaining technologies are presented in Appendix I.

Figure 5 Technology mix of the automotive industry



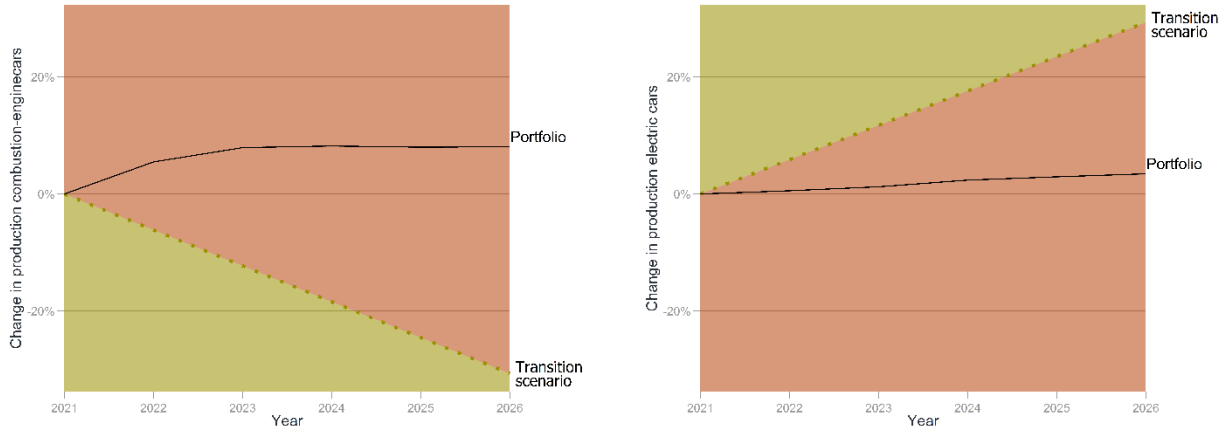
The bars indicate the share of different powertrain technologies in the total car manufacturing capacity of companies in banks' loan portfolios. The top bar shows the current situation (2021). The middle bar shows what the situation will be in 2026 according to the plans of the companies that have received loans. The bottom bar shows what the technology mix should be according to the transition scenario.

Sources: Asset Resolution, PACTA, DNB.

The increase in electric car production will lag behind in the coming years, while the production of combustion-engine cars will not decline. Figures 6a and 6b show the production plans of car manufacturers financed by Dutch banks compared with the transition scenario. The dotted line in Figure 6a falls because the production of combustion-engine cars will have to decrease by about 30% by 2026. This decrease is not reflected in companies' plans, however. On the contrary: production of combustion-engine cars actually increases in the initial years. This is partly because the car manufacturers in banks' loan portfolios produce for the global market, and this market is still growing. Moreover, Figure 6b shows that the production of electric vehicles is not increasing quickly enough to meet the 2026 goal.[17]

[17] See Appendix I for hydrogen and hybrid car production volumes.

Figures 6a and 6b Production volumes of combustion-engine cars and electric cars



The solid line represents the projection of the production of companies in banks' loan portfolios and the dotted line between the green (lighter) and red (darker) area represents the production path required to limit global warming to 1.5°C by 2050. If the solid line moves into the red area, the production projection of companies in banks' loan portfolios is insufficient to meet the climate agreement goals. If this line is in the green area, companies are adapting faster than the transition scenario requires.

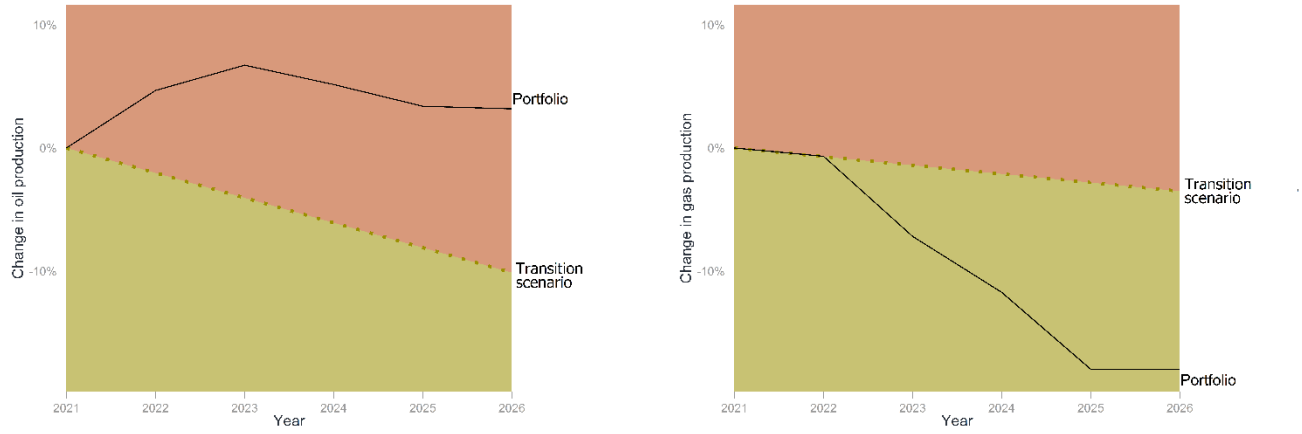
Sources: Asset Resolution, PACTA, DNB.

Oil and gas production

According to the business plans, oil production by companies in Dutch banks' loan portfolios will not decline sufficiently by 2026. Oil production will even increase by more than 6% by 2023. Production will decrease thereafter, but it will remain higher than the 2021 level, whereas a 10% decrease compared to the base year is needed to meet the requirements of the scenario. This means that transition risks are present in this sector as well.

The plans of the companies active in natural gas extraction show a stronger collective drop in production than the scenario requires, meaning transition risks are limited at the aggregate level, but some of the companies do face transition risks. The slightly descending dotted line in Figure 7b indicates that natural gas production will not have to decline as much as oil production in the coming years, according to the transition scenario. This is because natural gas is considered to be a bridging technology. Nevertheless gas production by companies financed by Dutch banks will drop by 15%. It is important to note here that this decrease is the result of the plans of all companies in this sector combined, and that some banks have also extended loans to companies in this sector that do not plan to phase-out gas extraction. These companies pose an increased risk and it is important that banks manage this risk adequately. The reduction is sufficient at the aggregated level mainly because of the cessation of gas extraction in the Province of Groningen.

Figures 7a and 7b Oil and gas production volumes



The solid line represents the projection of the production of companies in banks' loan portfolios and the dotted line between the green (lighter) and red (darker) area represents the production path required to limit global warming to 1.5°C by 2050. If the solid line moves into the red area, the production projection of companies in banks' loan portfolios is insufficient to meet the climate agreement goals. If this line is in the green area, companies are adapting faster than the transition scenario requires.

Sources: Asset Resolution, PACTA, DNB.

4 Conclusions

Banks are exposed to transition risks because some of the companies they lend to are not transitioning to low-carbon alternatives quickly enough. The transition in production from internal combustion-engine cars to electric cars and the decline in oil production are lagging behind the transition scenario. While lending to companies that produce renewable energy is already high, it will not increase enough in the coming years to meet the goals of the Paris Climate Agreement. Consequently, fossil power generation will remain too big a part of the power mix. The decline in bank lending to companies involved in gas extraction is on target.

These increased transition risks could lead to credit losses if companies that lag behind are squeezed by tighter government policies, legal rulings or changing consumer preferences. The probability of stranded assets increases for companies engaged in activities that must be reduced to meet alignment targets. For activities that need to increase, such as renewable energy, companies will have to invest more to close the gap with the alignment targets. Incidentally, this does not necessarily mean that banks should avoid lending to carbon-intensive sectors. Banks can engage with companies in an effort to persuade them to adapt their operations to the transition to a sustainable economy.

There are large differences between banks when it comes to transition risks. In this analysis, we provide an overview of the exposure of the aggregate loan portfolio of Dutch banks. However, this overview conceals the differences between banks and between companies within a single loan portfolio. Banks should apply this or a similar analysis to their own portfolio and the individual companies in their portfolio.

Finally, our analysis represents a lower boundary of transition risks because we concentrate on sectors with high carbon emissions. It is to be expected that companies in the chain that do not operate in line with the Paris Climate Agreement are also exposed to transition risks. In the automotive industry, for example, suppliers of combustion-engine components are vulnerable to an accelerated transition to electric vehicle production, but these have been excluded from this analysis. The transition risks that these companies run depend on their exact activities and are thus more difficult to identify. A producer of automotive gearboxes, for example, will be significantly affected by the transition, but a producer of car seats or windscreen wipers is unlikely to experience much impact because these components are also used in electric vehicles. It is not yet possible to use the PACTA methodology to determine exactly *whether* and *how* these companies will be affected by the transition, but it is important that banks nevertheless factor these risks into their lending process.

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Appendix I – other results from core sectors

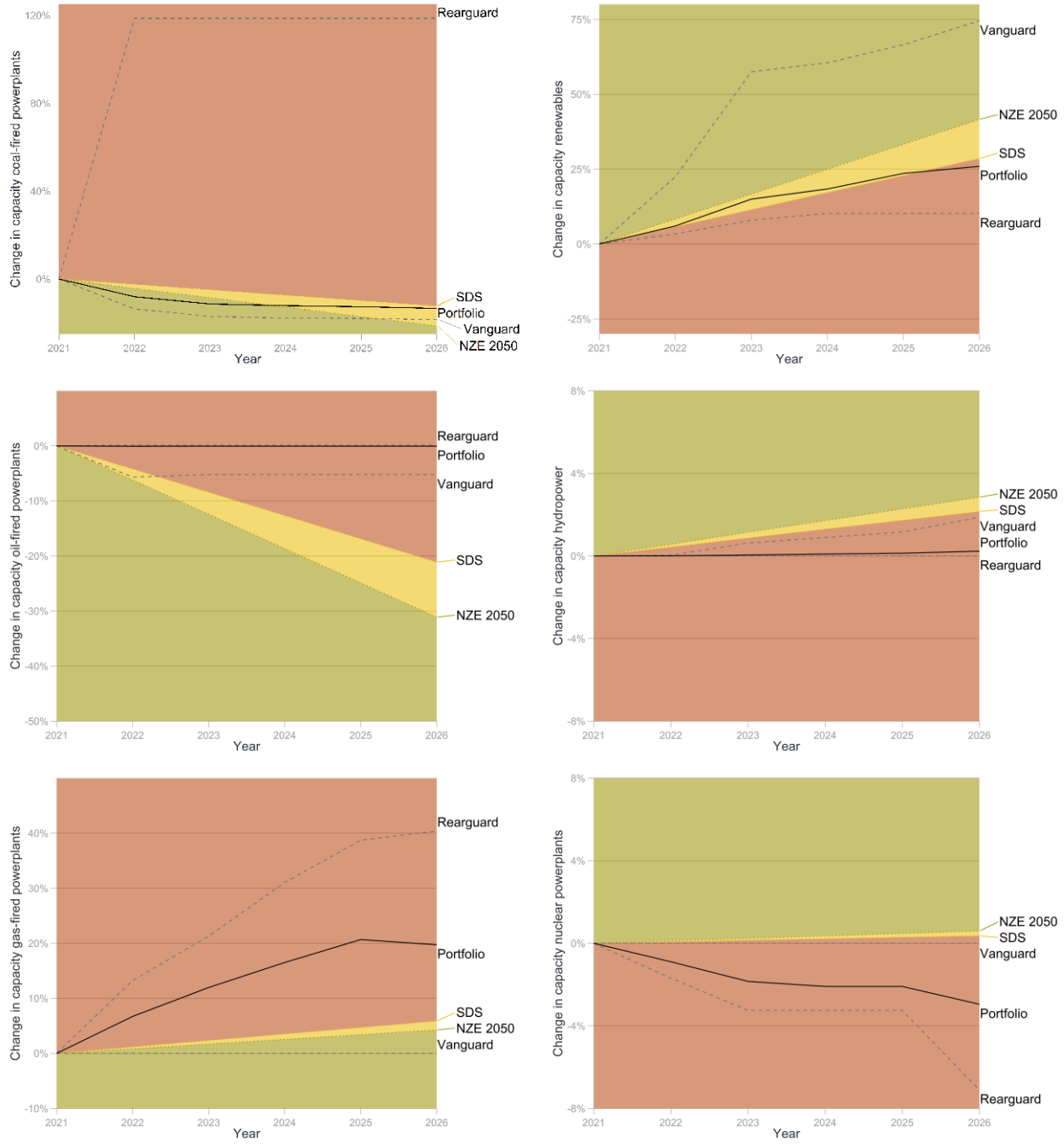
In addition to the main results described earlier, this appendix also presents results for other technologies within the power generation and automotive sectors. It also presents results for the Sustainable Development Scenario for the different sectors. Under this IEA scenario there is a 50% probability of a 1.7°C global temperature rise by 2050. Finally, all figures also show the loan portfolio of the bank that is most ahead in the transition and the bank that is most behind.

Power generation

For power generation, we also looked at hydropower, nuclear power and gas- and oil-fired power plants. The results for these technologies are shown on the next page (the results for coal-fired power plants and renewable energy are presented in the main body of this report). These figures also show the results for the scenario involving a temperature rise of 1.7°C by 2050. Of the 11 banks in the data, 10 have exposures to companies in the power generation sector. For all six technologies, the companies in banks' loan portfolios combined fall short of the transition scenario to limit global warming to 1.5°C by 2050. Apart from coal-fired power plant capacity, this also applies to the path to a 1.7°C rise by 2050.

Regarding renewable energy generation, there are also banks with loan portfolios that are ahead of the scenario, while for gas-fired power generation this holds for one bank. For all other technologies, all banks' loan portfolios are lagging behind the scenario to limit global warming to 1.5°C by 2050. Investments in oil, hydropower and nuclear power plants are only a fraction of investments in the other technologies.

Figures 8a to 8f Production capacity of different forms of power generation



The solid line is the projection of the production capacity of companies in banks' loan portfolios. The dotted line between the green and yellow areas shows the production path to limit global warming to 1.5°C by 2050. The dividing line between the yellow and red areas shows the production path to limit global warming to 1.7°C by 2050. When the line moves into the green area, companies are adapting faster than the transition path requires to limit global warming to 1.5°C. If the line moves into the yellow area, the capacity of companies is in line with the transition path to limit global warming to between 1.5°C and 1.7°C by 2050. If the line moves into the red area, the production capacity is not in line with either transition scenario. The lower (left figure) and upper (right figure) dotted line represents the portfolio of a Dutch bank that is most ahead of the transition. The upper (left figure) and lower (right figure) dotted line represents the portfolio of a Dutch bank that is lagging furthest behind the transition paths.

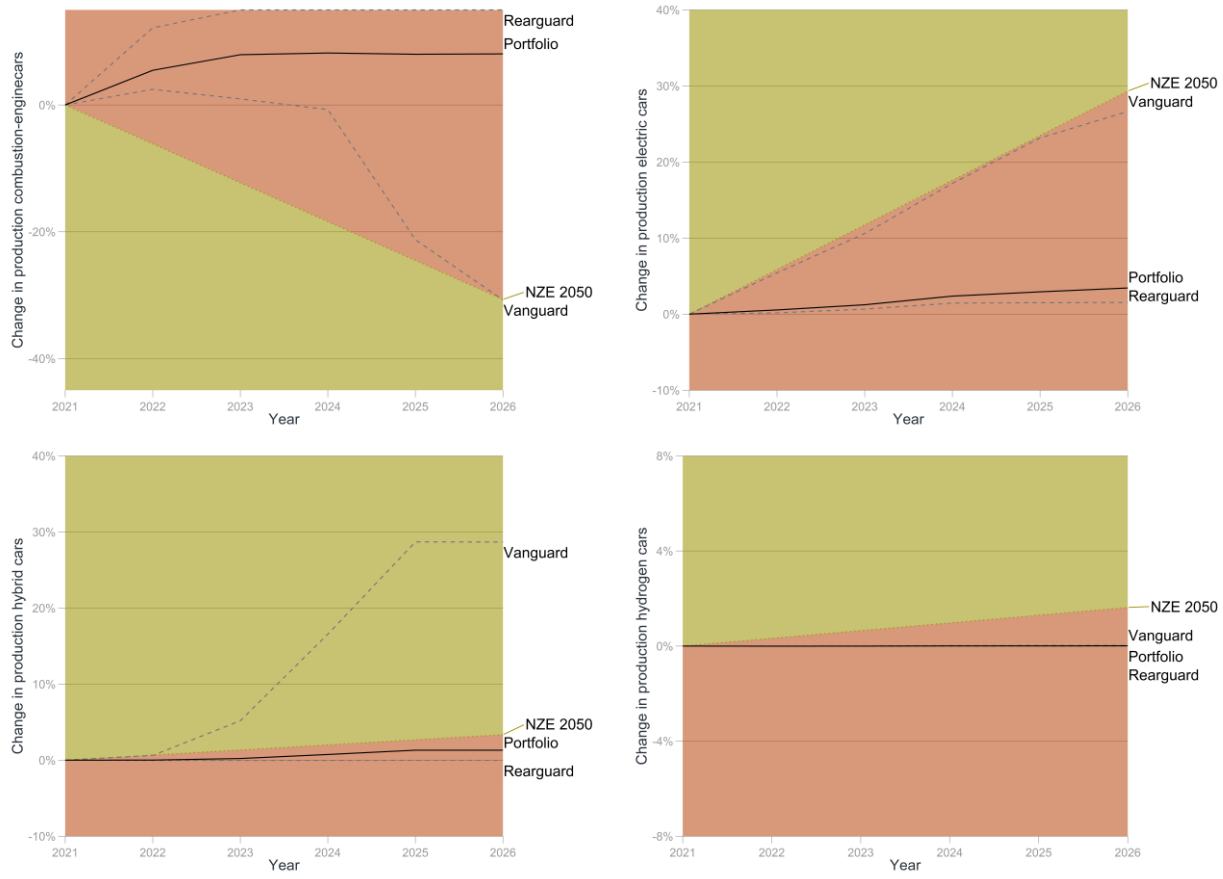
Sources: Asset Resolution, PACTA, DNB.

Automotive sector

In the automotive sector, in addition to results for the production of combustion-engine cars and electric cars, results are also available for hybrid and hydrogen powered cars. The figures below also show the bank that is most ahead in the transition and the bank that is most behind. Five of the eleven banks have exposures in the automotive sector. For all four types of powertrains, companies in banks' loan portfolios are collectively lagging behind the transition scenario.

There are also banks whose loan portfolio is ahead of the transition path with regard to the phasing out of combustion-engine car production and an increase in hybrid car production. However, the production of electric cars and hydrogen-powered cars lags behind the scenario for all banks. Investment in hydrogen-powered car production is very minor compared to the other technologies. The Dutch banking sector is not yet involved in financing the scale-up of hydrogen-powered car production. The Sustainable Development Scenario is not available for the automotive sector, meaning no results can be shown for this scenario.

Figures 9a to 9d Production volumes of cars with different powertrains



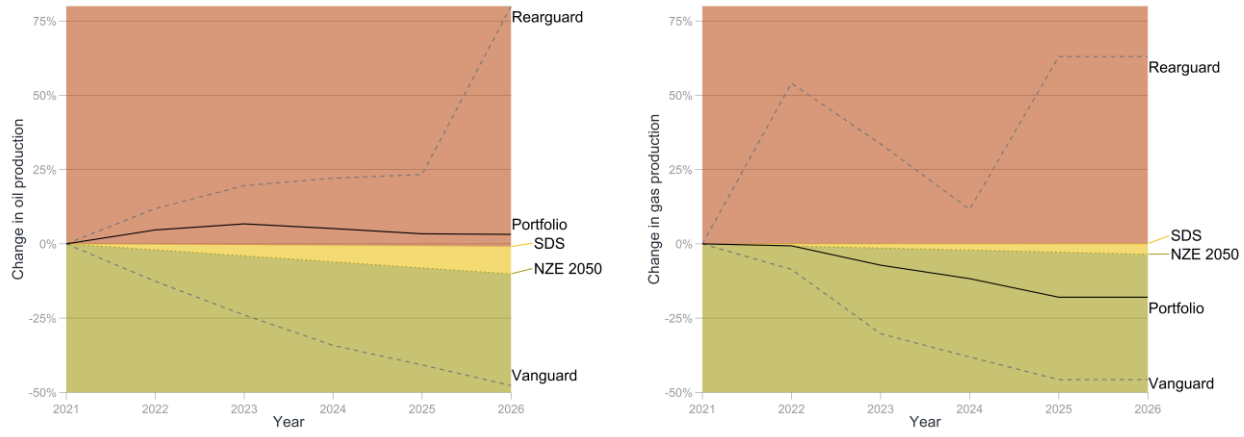
The solid line represents the projection of the production of companies in banks' loan portfolio. The dotted line between the green and red areas represents the production path to limit global warming to 1.5°C by 2050. When the line moves into the green area, companies are adapting faster than the transition path requires to limit global warming to 1.5°C. If the line moves into the red area, the production projection is not in alignment with the transition scenario. The lower dotted line in the top-left figure represents the portfolio of a Dutch bank that is most ahead of the transition. The upper dotted line in the top-left figure represents the portfolio of a Dutch bank that lags most behind the transition paths. These are reversed in the other three figures above.

Sources: Asset Resolution, PACTA, DNB. 6

Oil and gas sector

For the oil and natural gas sector, in addition to the results for the Net Zero Emissions by 2050 Scenario, results are also available for the Sustainable Development Scenario. For each technology moreover, these figures show the bank that is most ahead in the transition for this particular sector and the bank that is most behind. Five of the eleven banks have exposures to companies involved in oil and gas extraction. For the oil sector, one bank has a loan portfolio that is ahead of the transition paths, while other banks' loan portfolios lag behind. For one bank, the increase in production by companies in its loan portfolio is even close to 200%, whereas production must decrease to meet the transition scenarios. Gas production by the combined companies in one bank's loan portfolio is decreasing significantly faster than the scenario prescribes to limit temperature rise to 1.5°C, while gas production by companies in the loan portfolios of two other banks is actually increasing.

Figures 10a and 10b Oil and gas production volumes



The solid line represents the production projection of oil and gas companies in banks' loan portfolios. The dotted line between the green and yellow areas shows the production path to limit global warming to 1.5°C by 2050. The dividing line between the yellow and red areas shows the production path to limit global warming to 1.7°C by 2050. When the line moves into the green area, companies are adapting faster than the transition path requires to limit global warming to 1.5°C. If the line moves into the yellow area, the capacity of companies is in line with the transition path to limit global warming to between 1.5°C and 1.7°C by 2050. If the line moves into the red area, the production projection is not in alignment with either transition scenario. The lower dotted line in the figures represents the portfolio of a Dutch bank that is most ahead of the transition. The upper dotted line represents the portfolio of a Dutch bank that is lagging the most behind the transition path.

Sources: Asset Resolution, PACTA, DNB.

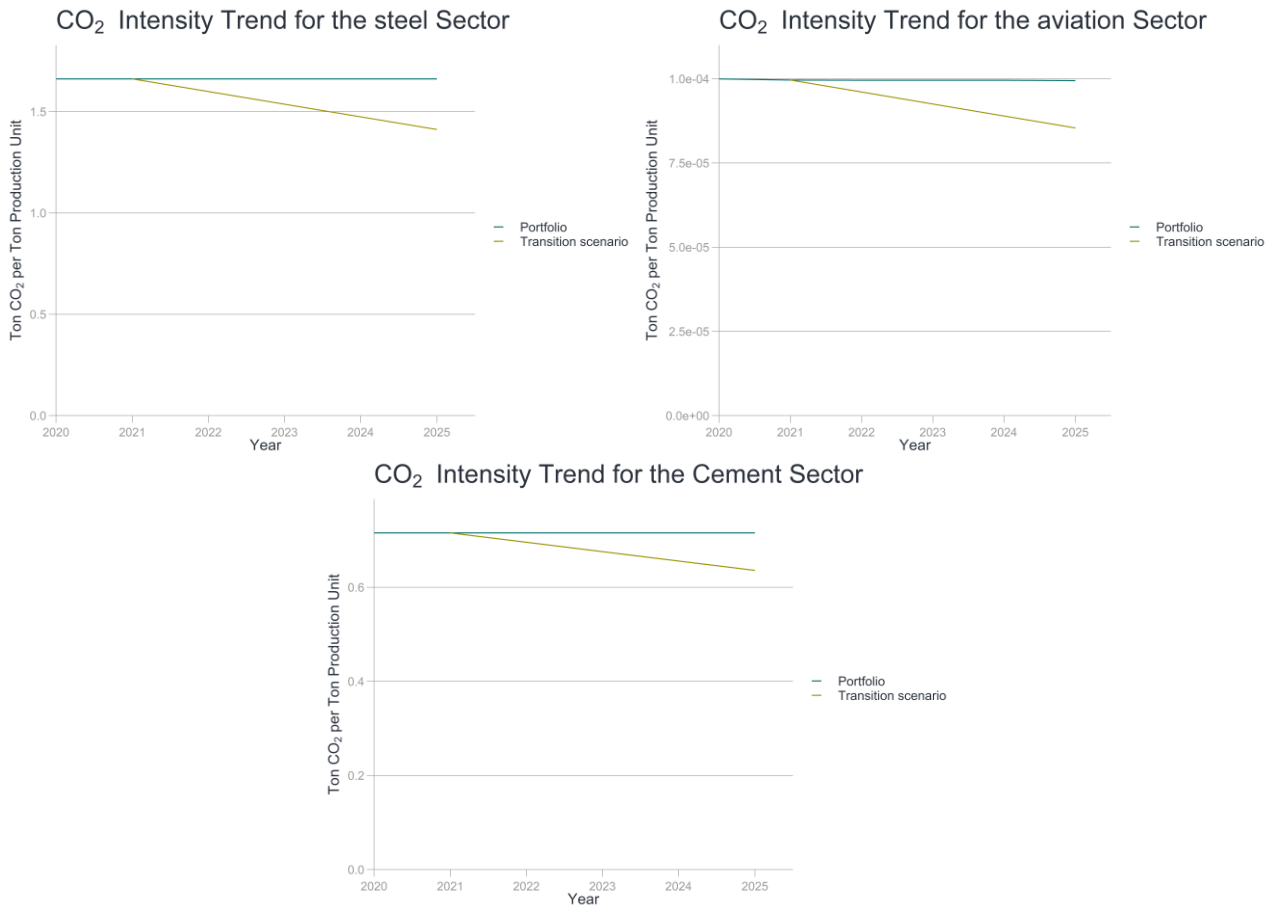
Appendix II - results for cement, steel and aviation sectors

Cement, steel and aviation sectors

Low-carbon technology is unavailable for the cement, steel and aviation sectors. Carbon intensity is thus used as a measure. This is the amount of carbon emissions per unit of output: for steel production the carbon emissions per tonne of steel, for cement the carbon emissions per tonne of cement and for aviation the carbon emissions per 1,000 passenger-kilometres.

The companies' plans for the coming years in these sectors are unclear, however. To give an indication of how much these sectors would need to adjust, the required change in carbon intensity has been calculated using a different scenario: the ISF net-zero scenario, with a 66% probability of a 1.5°C increase in global temperature by 2100. The results show that carbon intensity would have to decrease by about 15-20% for all three sectors.

Figures 11a to 11c carbon intensity of the cement, steel and aviation sectors



The dark line represents the projected carbon intensity of portfolio companies, and the light line shows how carbon intensity would have to change to limit global warming to 1.5°C by 2100 with a 66% probability.

Sources: Asset Resolution, PACTA, DNB.

Appendix III – the methodology further explained

We used the PACTA for banks methodology to gain insight into the extent to which Dutch banks' loan portfolios are aligned with climate transition scenarios.[18] In describing the methodology, we rely on the PACTA for Banks Methodology Document.[19]

From scenario level to company level

PACTA for Banks makes it possible to use different transition scenarios. Just as for the measures, a distinction is made between whether or not a low-carbon technology is available for a specific sector.

Low-carbon technology available: In this category, a distinction is made between activities that must decrease, specifically carbon-intensive activities, or increase, specifically low-carbon activities.

Decrease: first, the decarbonisation target for each technology was set in a transition scenario. The total target was then distributed proportionally among the companies in the sector according to each individual company's market share. If the volume of total oil production must decrease by 50% in the transition scenario, then the oil production of each individual oil producer must decrease by 50%. The market share of each oil producer thus remains the same.

Increase: The transition scenario calls for an increase in renewable energy generation and electric vehicle manufacturing. For these technologies, you cannot base the required change on the current market share of the technology. Indeed, this would mean that a company that mainly produces electric cars would have to produce a much larger proportion of the electric cars needed than a company that now mainly produces combustion-engine cars. The first step in the scenario is therefore to determine the total amount of low-carbon production for the sector. Then, based on the company's share of total production, the share that a company must produce using low-carbon technologies to meet the transition scenario is calculated. The change required is thus not calculated relative to the market share of a technology, for example the share in total production of electric cars, but relative to the market share in the sector, i.e. the share in total production of all cars combined.

Low-carbon technologies not yet mature: the carbon intensity required to operate in line with a transition scenario is calculated for the cement and steel sectors. Each company in the sector must then reach the target by the end of the scenario's duration, regardless of its carbon intensity at the start of the scenario. A company already operating with a relatively low carbon intensity will face a lower hurdle than a company operating with a relatively high carbon intensity.

Aggregating from asset level through company level to loan portfolio

We look at asset-level data to determine how active a company is in a sector. The criterion is thus set per oil field for a producer with multiple oil fields. We then aggregate from the lowest level to the company level: aggregation within the company. Banks extend loans to multiple companies. To arrive at the result for a bank, we aggregate from the company level to the portfolio level: aggregation within the loan portfolio.

[18] This methodology can also be applied to an individual company to assess its alignment with a transition scenario. This is a useful approach for gauging an individual company's transition risk.
[19] PACTA for Banks Methodology Document [link].

Within company

Ownership shares are used to aggregate the various assets within the company. If company A owns x% of asset 1, then x% of the production of asset 1 is allocated to company A. This is done for all assets owned by company A. To aggregate intensities, the weighted average, based on production volumes, is derived from the various assets. If company A is owned by other companies, then company A's production / intensity is allocated to the company with a majority stake.

Within loan portfolio

Finally, to determine portfolio alignment, the companies in the loan portfolio are aggregated by sector in proportion to their weight in the loan portfolio. In other words, a company's production is multiplied by the proportion of loans extended to the company relative to the total loan portfolio.

Output

The steps outlined above produce the current production / intensity of companies and, after calculating in portfolio weightings, an estimate of current production financed by the loan portfolio. Based on the investment plans of these companies, the production / intensity for the next five years can be projected. Both the current situation and the projection are compared to the transition scenario selected to determine the extent to which the loan portfolio is in line with the scenario.

Data

We use the AnaCredit[20] Q4 2021 data for the loan portfolio of Dutch banks. AnaCredit is a database of loans of at least €25,000 extended by European credit institutions. We use loans in AnaCredit with a valid maturity of more than 1 day, a valid NACE sector code and that are on the bank's balance sheet.
We use the Asset Based Company Data (ABCD) of Asset Resolution (AR) for production volumes, installed capacity and carbon intensity at the asset level. Asset Resolution's publicly available ABCD[21] consists of over 72,000 companies operating in the PACTA sectors. In the next section, we provide an overview of the AnaCredit and AR variables used and describe how the datasets are linked.

[20] Further information about AnaCredit can be found on the ECB's website [link].
[21] ABCD data can be obtained from RMI [link].

Table 2.1 Overview of AnaCredit variables

FIELD	DESCRIPTION
DEBTOR_NAME	Counterparty name
DEBTOR_RIAD_CD	Counterparty riad code
DEBTOR_LEI	Counterparty Legal Entity Identifier (LEI)
ULT_PRNT_NAME	Counterparty ultimate parent name
ULT_PRNT_RIAD_CODE	Counterparty ultimate parent riad code
IMMT_PRNT_NAME	Counterparty immediate parent name
GRP_HD_ENTTY_RIAD_I	Riad id of head of counterparty group
IMMT_PARENT_NACE	NACE code
ECNMC_ACTVTY	Counterparty economic activity (NACE[22])
SUM_ONA_SHARE	Loan amount outstanding
OA_NAME	Bank name
OA_RIAD_CD	Bank riad code

Table 2.2 Asset Resolution variables

FIELD	DESCRIPTION
NAME_COMPANY	Company name
LEI_CODE	Company LEI code
SECTOR	Sector in which company operates
TECHNOLOGY	Asset technology
YEAR	Year of production
IS_ULTIMATE_OWNER	Whether the company is the ultimate owner
EMISSION FACTOR	The carbon intensity of the asset
PRODUCTION	Asset production

Link between AnaCredit and ABCD

It takes a number of steps to link companies in AnaCredit to companies in ABCD:

1) By LEI at counterparty level: the LEI code of the counterparty is linked to the LEI code in the ABCD;
2) By name at counterparty level: the name of the counterparty is linked to the name in the ABCD using a string matching algorithm[23] . The algorithm must return a score of at least 90% or we do not accept the match;
3) These steps are subsequently repeated at the level of immediate parent, ultimate parent and group head. The LEI code supersedes the name of the counterparty for all potential links. Here, too, we require a matching score of at least 90%.

[22] See Statistics Netherlands (CBS) for a description [link].
[23] The matching algorithm is available at [link].

Sector-level link

The NACE code is used to determine whether a counterparty belongs to a sector relevant to the analysis. The loan will be included if the ABCD sector matches the NACE code sector. This is to prevent misclassifications, e.g. an oil producer with solar panels on its roof being classified as a renewable energy producer.

If the counterparty's NACE code does not correspond to the relevant sectors, we then look at the size of its production in the ABCD. If the company accounts for at least 5% of the maximum production in a sector, the NACE code is adjusted to this sector, resulting in a counterparty link.
If banks use different NACE codes for a single counterparty, then we use the counterparty's NACE code that corresponds to the largest share of loans (weighted by outstanding amount).