Barclays PLC

Corporate Transition Risk Forecast Model 2021

BARCLAYS

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Introduction

Scenario analysis plays an important role in assessing the future implications of potential climate change pathways on Barclays', and is a key part of the organization's approach to climate risk management.

If the transition to a low-carbon economy happens too slowly, climate change could have devastating effects on our planet. If the transition is disorderly, there could be very real social and economic costs for families and businesses around the world – from unemployment and financial hardship, to insufficient food and fuel to meet their daily needs. We must weigh and balance those risks in order to maximise our contribution to addressing the climate challenge.

Against this backdrop is an evolving regulatory landscape, with many regulators increasing their oversight and expectations of climate risk management in recent years. In 2019, Barclays' principal regulator, the PRA, published a Supervisory Statement outlining requirements for a strategic approach to the management of the financial risks posed by climate change. These were enhanced in July 2020, setting a deadline for implementation of end 2021.

Central Banks and regulators are also increasingly engaging in supervisory stress tests to understand the climate vulnerabilities of participants, including the Bank of France/ French Prudential Supervision and Resolution Authority, the Netherlands Bank (DNB), the Bank of England and the Prudential Regulation Authority, and the European Central Bank.

Climate change is a global and pervasive risk and opportunity to companies and there will inevitably be winners and losers across all sectors. Assessing this impact requires new approaches and tools, which consider both climate, macro-economic and sector and company specific factors. Barclays started assessing those impacts in 2018, initially qualitatively and has since aimed to create quantitative methodologies for several of its key portfolios. These new approaches and tools focus on company level analysis, which differs from more traditional stress testing exercises, conducted at portfolio or sector level, as a counterparty unit of analysis better captures the novel risk driver's climate change presents. To support this, Barclays developed a methodology to assess the impacts of future climate transition scenarios on corporate companies from economic sectors that Barclays considers to be subject to elevated climate risk (as defined in our TCFD report). This methodology produces revised future financial metrics impacted by such scenarios, which can in turn be used in credit risk assessments.

This methodology is first generation and is focused on capturing the directionality and magnitude of climate change impacts to companies, rather than achieving a high degree of accuracy. Over time it is expected that this approach will evolve and be refined as data availability improves and methodological techniques are refined. This whitepaper is shared in this spirit, to add to the growing body of literature on how to assess the risks arising from climate change, to invite feedback and to support other actors in developing their approaches to this field.

The key design principles of the methodology are outlined below, across the input data required, the assessment performed and the resulting financial and credit impacts. Greater detail is included in subsequent sections outlining how each of these steps is operated and integrated into the overall methodological approach.

1. Input Data

Scenario Variables
- Commodity demand and prices
- Low/high carbon product demand
- Carbon prices

Company Data
- Revenue, costs and earnings
- Net debt
- GHG emissions

Internal Credit Metrics
- Credit ratings (Default Grade)
- Exposure at default
- Loss given default

2. Assessment

Adaptation
- Actions to mitigate climate risks
- Impacts to revenues and emissions
- CapEx from shift in low/high carbon activities

Carbon Costs
- Carbon tax from GHG emissions
- % carbon costs passed to next consumer

Gross Profit
- Changing prices for fossil fuels
- Changing demand for goods and services on revenue and costs

3. Financial and Credit Risk Impact

Financial Impact
- Forecast future revenue, gross profits, earnings and net debt

Credit Scorecard
- Assess 3 factors:
  - Size
  - Profitability
  - Leverage

Downstream models
- Climate adjusted future credit rating

1 Input Data

1.1 Scenarios

The purpose of the methodology is to calculate future company level financial and credit metrics, impacted by the climate specific transition scenario being assessed. To that end, it is capable of consuming a wide range of scenarios depending on the objective of the assessment. It has in particular been designed to utilise scenarios developed by the Bank of England in the context of its 2021 Climate Biennial Exploratory Scenario (CBES) and by the Network for Greening the Financial System (NGFS), including Orderly and Disorderly transitions.

Whilst the methodology is capable of running various transition scenarios, in order to support the assessment granularity, the scenarios being used should include a wide variety of demand and price curves for commodities and products and services. This includes for example, power capacity, fossil fuels, transport capacities and products such as cement and steel. Throughout this report, NGFS scenarios are used to demonstrate examples of the methodology, specifically the Orderly Net Zero 2050 scenario, which informed the Bank of England's Early Action scenario. It is worth noting that Barclays expanded certain scenario variables that were not published.

1.2 Company Data

To perform granular assessments of the impacts of future climate scenarios on corporate companies, the methodology requires detailed information on the company, including i) financial metrics, ii) emissions data and iii) internal credit metrics. It is important that relevant information about the company is isolated as of today, to subsequently apply the impact of future climate scenario variables.

Obtaining data is challenging, across a number of different dimensions including data sourcing, granularity, and format. As a result, estimation techniques and proxies are often required in order to perform the assessment. The increase in companies disclosing climate risk information in TCFD reports has driven a significant increase in the number of data points available to perform the assessment, in turn lowering the reliance on estimations. This should increase the validity of the assessments performed.

1.2.1 Company Financial Data

For financial data, the corporate population is segmented into different sectors according to the principal business activity they perform. Company's activities are further attributed to key sector specific technologies, according to the revenues they generate from these products/services. These technologies have been chosen as they are deemed to be the most important business segments impacted from a climate change perspective. It is noted that some companies operate across a multitude of activities, and in the future the methodology aims to make these technologies sector agnostic so that revenues can be attributed to any technology irrespective of the sector in which the company operates. However, these instances are small in number and in many cases additional operations for companies within a sector, not captured within the chosen technologies, will face minimal impacts from climate change. In such cases, increasing the number of the possible technologies per sector does not add additional analytical value. The methodology currently treats these Revenues as "Other" and holds these constant over the scenario forecast.

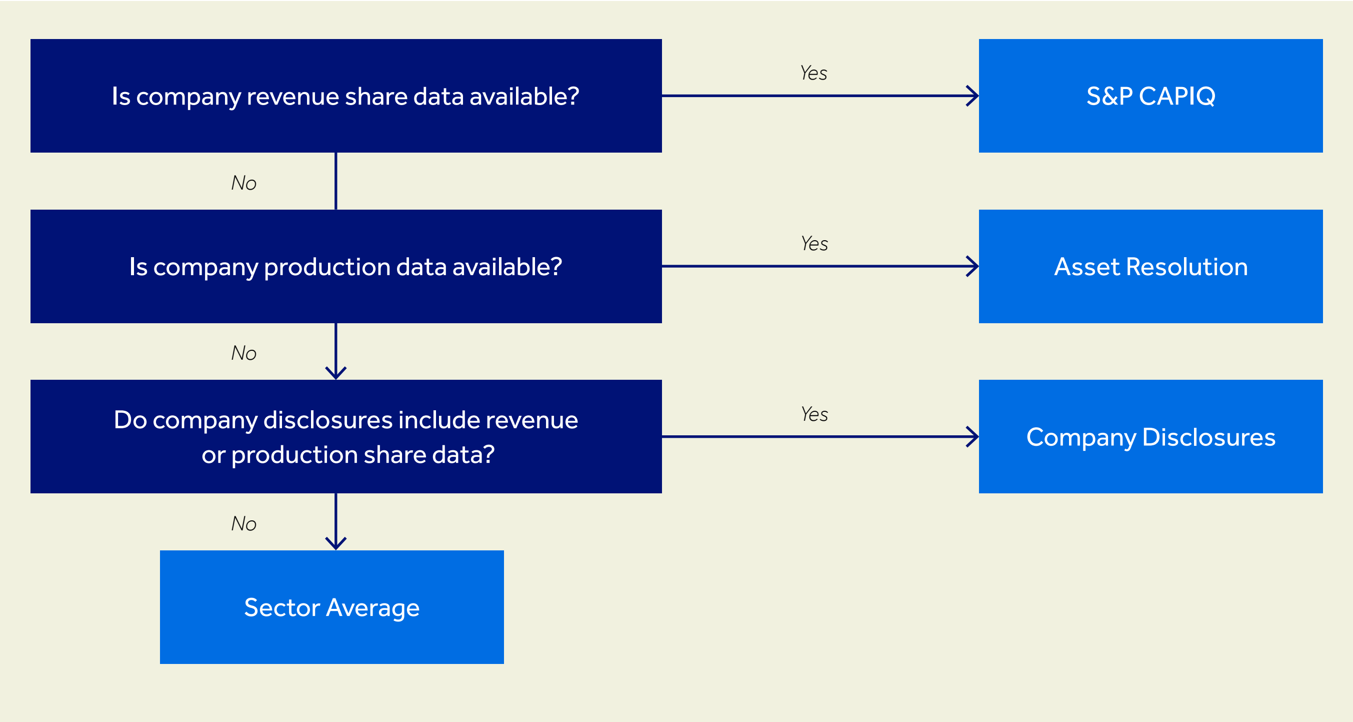
This segmentation and attribution generates a detailed picture of the companies' starting business model that can be used to forecast the impact of scenario variables. The below table demonstrates sectors and technologies considered:

	Technology				
	Type 1	Type 2	Type 3	Type 4	Type 5
Agriculture	Crop Production	Animal Production	Trading		
Automotive Manufacturing	Internal Combustion Engine	Hybrid	Electric Vehicle		
Aviation	Air Travel				
Cement	Cement				
Chemicals	PetroChem	Non-PetroChem			
Coal Mining and Coal Terminals	Coal Mining	Other Mining			
Mining	Coal Mining	Transition Metal Mining	Other Mining		
Oil & Gas	Oil (Margin based)	Gas (Margin Based)	Oil (Production based)	Gas (Production Based)	Renewables
Power Utilities	Coal Power	Gas Power and Distribution	Nuclear Power	Renewable Power	Electricity Transmission and Distribution
Road Haulage	Road Haulage	Logistics			
Shipping	Shipping	Logistics			
Steel	Steel				

As an example, for a company operating in the Automotive Manufacturing sector, current financial performance is segmented into revenues generated through the sale of internal combustion engine (ICE), hybrid and electric vehicles (EV). This enables a better understanding of the company's current exposure to products and services that will be impacted by the transition to a low carbon economy, in this case the increase in sales of EVs versus the decline in the sale of ICE vehicles. Those operating in this sector will be subject to these demand shifts, which will in turn have a knock on impact on revenues, whereby those able to produce greater volume of EVs will be better able to benefit from the transition and outperform peer competitors. Likewise, in the Mining sector, companies with significant coal activity are likely to face more challenging business environments than those with less, and vice versa for companies with greater transition metal activities.

The choice to focus on revenue generation as the underlying performance metric represents a key design choice, where revenue is used as a substitute to modelling underlying production. This is recognition of the cross-sector application of this approach, and the lack of readily available data on company's performance in terms of production, meaning that revenue generation provides a consistent and reliable metric on which to forecast future financial performance across sectors. The implication within this is that margins associated with production are both the same across technologies within a sector and remain constant over time, which given the long term nature of these scenarios and differentiation of technologies within sectors, is in reality likely to be variable. However, the ability to model such changing margins is currently beyond the scope of this methodology.

A number of data sources are used to breakdown revenues by technology type. Such data can be challenging to obtain, and certain sectors are less prone to disclose revenue split across these technologies. A waterfall hierarchical approach is used to capture actual revenue share data, or estimations with the proportion of total revenue across technologies, where this is not available.



1.2.2 Company emissions data

The greenhouse gas emissions of corporate companies, both current and future, also represents a key metric when assessing the future financial impact of the transition to a low carbon economy. As governments around the world seek to reduce GHG emissions through greater regulation, the resultant policy decisions are likely to generate winners and losers depending on how significantly companies can reduce their emissions footprint.

Data availability for company emissions is continuously improving, as more companies begin to disclose this information as well as greater numbers of external third party providers providing estimation methodologies. This methodology combines both company level disclosures where available and sector-level estimate where not. These estimation approaches are in line with the methodologies taken by many leading third party vendor approaches. It sums both the scope 1 and 2 emissions of companies, but does not capture the direct impact of scope 3 emissions, as these are assumed to be indirectly factored into the demand shocks inherent in the scenario (see section 2.1 for more detail).

Company disclosure data on emissions is used as the primary source, noting that it is most likely to represent the in-scope GHG emissions the company would face under carbon pricing regimes. Where this is not available, a two-step estimation based on financial intensity is used:

- Calculate sectoral level financial intensity metrics, using revenues per tonne of carbon dioxide equivalent emissions for companies within those sectors.
- For companies with missing emissions data, multiply revenues by the financial intensity metric to obtain estimation of the company's emissions.

The above approach represents a simplifying method for obtaining emissions estimates, given that with financial emissions intensities within a sector may well deviate on a company by company basis, as GHG emissions are driven by a large number of factors. One of its key benefits is that it can be implemented consistently across a wide range of sectors, company sizes and organisational types.

1.3 Internal Credit Metrics

The use of internal credit metrics such as Default Grade (DG), Loss Given Default (LGD) and Exposure at Default (EAD) is not required to calculate financial impacts to companies, however this information is used when translating future financial impacts to credit impacts. These data inputs are obtained from existing internal credit systems. Barclays DG is the internal credit metric used as part of company credit assessment and provides an integer representation of the probability of default of a company from DG1 (least risky) to DG22 (default). Further information on the assessment of credit risk impact can be found in section 3.2, and on Barclays DG scoring from Barclays Pillar 3 report.

2 Assessment

2.1 Gross Profit Calculation

The methodology treats future scenario impacts on financial performance as a sensitivity to a starting jump off point. In essence, the calculation takes the attributed revenues to each technology, and then calculates future revenue by using the appropriate scenario variable curve. For a hypothetical Mining company, Coal Mining, Transition Metals Mining and Other Mining are the technologies and the demand curve for each of these products can be applied to their starting revenues to indicate future revenues. In some sectors, this general approach has been further enhanced to include sector specific assumptions and dynamics. This currently covers Oil & Gas, Power Utilities and Automotive sectors given their central role in the transition to a low carbon economy. Further sectors would likely benefit from an enhanced approach as well, and the intention is that the methodology will evolve over time to include these.

2.1.1 General Approach

The approach projects income statement and balance sheet line items by establishing a link between the jump-off financial statements and scenario variables.

For total revenue projections, the equation is given below.

$$TotalRevenue_t = \sum_{s}^{s} [\Delta_{s,t} \times \Pi_{s,t}] \times AllocatedRevenue_{s,t} \tag{1}$$

Where delta represents the demand scenario variable and pi represents the price scenario variable for technology s (values are rebased as a ratio of the latest jump-off level).

AllocatedRevenue represents the jump-off revenue in the forecast (the latest actuals values), multiplied by the share of revenues a company expects to generate from a given technology as a fraction of its total revenues. Implicit in this calculation is the assumption that, absent of any companies within a sector changing their business model, market share would remain constant for all market participants and that any increasing demand for goods and services is met by firms. This is a simplification, and incorporation of assumptions on the interplay between market incumbents and new entrants is currently being considered as an additional module.

Cost of sales is modeled in a similar approach, with the notable difference that the market price of each technology is not considered as a factor for cost of sales. In other words, if the price of oil falls in the market, then a given oil producer will not incur decreasing cost of sales from its oil production based on the lower market price. Again, this is a simplification as it effectively assumes that the cost per unit of production remains static.

$$CostOfSales_t = \sum_{s}^{s} [\theta_{s,t} \times \Delta_{s,t}] \times CostOfSales_{t=0} \tag{2}$$

Note that the formula for cost of sales is similar to that of (1), with the notable exception that pi does not factor into the formula.

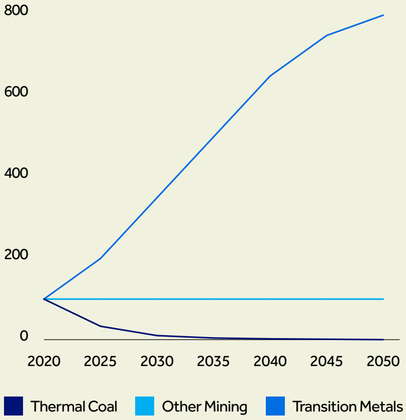
The net difference between total revenues and cost of sales is defined as gross profits.

$$GrossProfit_t = TotalRevenue_t - CostOfSales_t \tag{3}$$

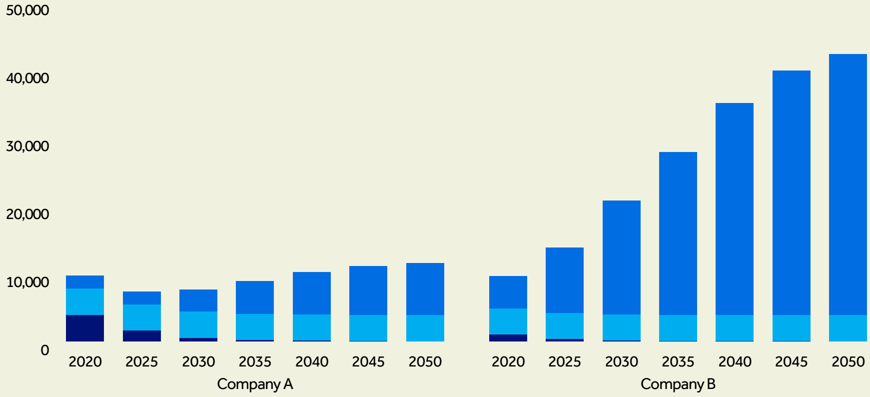
This includes variable costs directly incurred during the production of goods and services. The below graph demonstrates a hypothetical example for a Mining company, where the difference between two peer companies is only the starting business operations split across three technologies; Coal Mining, Transition Metals Mining and Other Mining. Given the difference in the future demand for these products, the fortunes of these two companies will diverge over time should neither take steps to evolve their business model.

In the below example, Company A generates 40% of its revenues from coal with only 20% from transition metals, whereas Company B is better positioned with half of its business revenue generated from transition metals and only 10% from coal. In both cases the remaining percentage of revenue is from "Other Mining" products, the demand for which is held flat over the scenario. As a result, Company B is well placed to take advantage of the transition and in turn grow its revenues substantially.

Mining Commodity Demand
%



Company Revenues
£mn



2.1.2 Oil & Gas Approach

Within this sector, revenue generation is split at a more granular level, to reflect two different revenue types. The first is where the Oil & Gas products that drive the revenue have initially been purchased by the company from a third party. These products may then be sold on immediately, for example in the case of Trading, or where the company transforms the product in some way before onward sale, for example in the case of Refining. In this instance, it is assumed that price dynamics in the scenario are less material, as broadly prices going up/down will affect both revenues and costs, and therefore cancel one another out with respect to overall financial performance (eg. profit/earnings). In contrast, revenue generation driven by raw Oil & Gas products that have been developed by the company themselves, for example Upstream production, will be more sensitive to price dynamics as falls/rises in price will impact revenues more significantly than costs.

For Oil & Gas (Margin Based) revenue, the formula given in (1) is simplified as follows:

:

$$TotalRevenue_t = \sum_{s}^{s} [\Delta_{s,t}] \times AllocatedRevenue_{s,t} \qquad (4)$$

For Costs, given the large reduction in oil & gas consumption in transition scenarios, it is reasonable to expect that companies would seek to manage down their cost base and their unit cost, for example by reducing production from their most expensive fields first. To reflect this, the methodology applies a scalar to reduce cost of sales, with γ in the formula below representing the cost efficiency measures. The extent to which a company can reduce these costs is calibrated based on the size of the company as a proxy for the extent to which cost efficiencies can be made i.e. the larger the company, the greater the cost efficiency improvements possible. For Oil & Gas Upstream sector, the cost of sales formula given in (2) is extended to the below.

$$CostOfSalesUpstream_t = UpstrCostOfSales_t \times (1 - 1_{t,scen} \times y) \qquad (5)$$

2.1.3 Power Utility Approach

Power Utilities is an important sector for the transition, both because of the projected electrification of the economy (leading to more electricity being consumed) and of the need to decarbonise the electricity grids by switching technology types.

For Power Utilities, total revenues are projected by linking jump-off total revenues to the growth in total electricity capacity. This contrasts to the general methodology where each technology is driven by its own demand driver.

$$TotalRevenue_t = \Phi_{ElectricityDemand,t} \times TotalRevenue_{t=0} \quad (6)$$

$$\Phi_{ElectricityDemand,t} = \frac{ElectricityDemand_t}{ElectricityDemand_{t=2020}} \quad (7)$$

The break-out between polluting sources of power and renewable sources of power is dependent on the credibility of the company's adaptation plan (see section 2.3 for how adaptation plans are assessed). For companies with credible adaptation plans, total revenue break-out will be based on the technology splits given in the company's adaptation plan, and scaled by the growth in total electricity demand. For companies with adaptation plans that are not considered credible, the generation capacity of polluting technologies will be held constant at today's level, and any increases in total electricity capacity is assumed to be met via new renewable capacity.

While under the methodology, the production technology does not impact revenue, companies that can adapt benefit from lower carbon taxes (see section 2.2 for details on carbon taxes). Companies with credit adaptation plans are able to replace fossil fuel power generation with renewables, as well as add new renewable power sources, whereas companies with non-credible plans can only add new renewable power. For the former, the replacement of fossil fuel sources lowers emissions and resulting carbon taxes. However, for companies with non-credible plans, the constant fossil fuel generation will lead to constant carbon emissions and higher taxes.

Finally, it is assumed that revenue generation is not directly linked to generation type as electricity prices are materially agnostic to generation fuel.

Cost of sales is linked to the percentage change in total revenues (i.e. the percentage change in total electricity demand), which implicitly assumes that unit cost remains constant.

2.1.4 Automotive Approach

For the Automotive sector, total revenue is based on the mix of technology across EVs, hybrid and ICE vehicles. The revenue forecast depends on whether the company has a credible or non-credible adaptation plan.

For companies with non-credible adaptation plans, revenues from ICE and hybrid vehicles are forecasted by linking jump-off revenues to the reducing demand in ICE vehicles and EV revenues are linked to the growth in total car demand. Their overall market share hence reduces over time.

$$\Phi_{AutoDemand,t} = \frac{AutoDemand_t}{AutoDemand_{t=0}} \quad (8)$$

For companies with credible adaptation plans, the revenue split by technology is driven by the adaptation plan, and is scaled by the growth in total auto demand. Credible adaptation plans are seen as enabling existing manufacturers to remain in line with the market demand for vehicles, whereas those unable to adapt will find their sales shrinking.

Cost of sales for all companies is linked to the change in overall auto demand times the jump-off cost of sales amount, which implies a constant unit cost.

2 **Assessment** continued

2.2 Carbon Costs

A carbon price is the financial cost associated with a unit of GHG emissions and can be implemented in a number of ways, including carbon taxes, cap-and-trade schemes and wider regulation on carbon intensive activities. There is no currently agreed global standard on how carbon pricing should work, however a number of governments and regulatory authorities have introduced such schemes, such as the EU Emissions Trading Scheme, South Africa's Carbon Tax and China's Emissions Trading Scheme. In addition, carbon price regimes can either target the source or use of GHG emissions by taxing fossil fuels based on carbon content when the fuel is burned, or through cap-and-trade schemes, which permit a certain level of emissions across a country or region, and use permits to ensure this level is achieved.

For simplicity, the methodology assumes that carbon price – which is typically provided in climate scenarios - takes the form of a carbon tax payable by the company. It applies a financial amount to each tonne of carbon dioxide equivalent emissions, across a company's Scope 1 (emissions associated with the burning of fossil fuels under their own operations) and Scope 2 emissions (those emissions associated with the provision of electricity and heat to their operations). This represents a key design choice; for the purposes of forecasting the impact of carbon pricing, it is assumed that carbon price regimes will avoid the potential double counting of including Scope 3 emissions, and therefore the approach does not include Scope 3 to improve the accuracy of the resulting financial impacts to a company. There are additional potential issues here, such as Scope 2 emissions reducing indirectly as power grids decarbonize, however such dynamics are not currently considered.

The approach also considers how these emissions will change over the scenario horizon. In the case where companies credibly commit to reduce emissions, the tax will be reduced accordingly. In addition, in the normal course of business, emissions will change as operational activity changes, even where no credible effort is made to reduce emissions. For example, an Oil & Gas Upstream company facing declining production as demand falls, will logically also see emissions fall. For a Power company, emissions are a function of the company's reliance on power generation from fossil fuel sources to continue to provide electricity to meet demand. Therefore, emissions will reduce if the company can replace fossil fuel based power sources with renewables, whilst remain flat if fossil fuel sources remain in place.

Carbon taxes may either affect the company's profitability or may be passed on to the company's customers in the form of higher prices for the goods they sell. The ability of a company to pass these additional costs through to its consumers will depend on factors such as the price elasticity of demand for the products, or the markets in which sectors operate.

The methodology uses differentiated pass-through rates for each industry, which has been determined based on a simple approach aiming to capture the perceived dynamics of the sector. Research done by Cambridge Energy Policy Research Group has been used to support the calibration of the extent of this pass through within industrial sectors, and then been extended out to all sectors in scope, using the formula below. These cost pass through rates are applied on a sector level.

$$p = (1 - s\%)\frac{N}{N + 1 + h} \qquad (9)$$

Where:

- N: Number of firms
- s: Scope of carbon cost-pass through - degree of unregulated firms dominate the market. Unregulated firms refer to those that are not subject to carbon tax due to the jurisdiction they operate in.
- h: Production constraint vs demand elasticity.

Calibrations have been made to this formula to reflect inherent data limitations as well as the theoretical nature of this formula compared to the practical application within this methodology. For example, arriving at a consistent definition of demand elasticity and marginal cost, on a sector level, for the production constraint factor was too difficult as different researchers show different demand elasticities for different time scales and geographic locations. Given the data issues above the below modifications have been made:

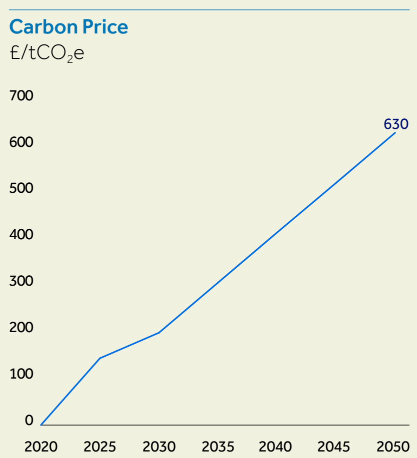
1. A range of 0 – 100 has been applied to h and N. This is to:
   a. Provide a simpler expert judgement based approach to determine the value of h and N, indicating the extent of production constraint and the level of competition.
   b. Remove extreme values from the input variables which could lead to large variants in cost pass through rates (more extreme values close to 100% and 0%).
2. Assumed s to be 0 under the assumption there is a global regulation of carbon tax, hence there is no 'carbon leakage' across jurisdictions. This means the market is fully regulated, corresponding to a value of 0. Given the long term nature of climate scenarios this is a simplifying assumption to reflect the challenges in calibrating this component with so many unknowns across the policy sphere.

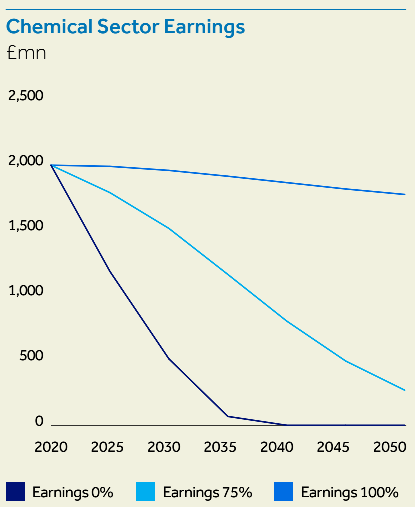
Using this approach and the associated modifications, the following pass through rates have been established:

Sector/Sub-Sector	Cost pass through rate to nearest 5%
Oil & Gas	100%-50%*
Power Utilities	75%-25%**
Chemicals	75%
Aviation	75%
Mining	70%
Cement	65%
Steel	55%
Agriculture	50%
Shipping	50%
Road Haulage	50%
Automotive	30%
Coal mining and terminals	40%

*set according to value chain segment
**set according to Regulated status of entity

The below example demonstrates the financial performance (earnings) of the Chemicals sector, under alternative cost pass through percentage assumptions whilst holding all other variables constant:





The below formula is used to estimate carbon taxes for a given company.

$$CarbonTax_t = Emissions_{t=0} \times CarbonPrice_t \times Revenue_t \times (1 - Passthru) \times (1 - Abate_t) \quad (10)$$

In the above equation, future carbon taxes are forecasted by multiplying the jump-off $CO2$ emissions for a given company, by the price of carbon (i.e. the carbon tax per $tCO2e$) times the company's forecasted revenues ratio (rebased to t=0), times the cost pass through ratio and emissions abatement ratio. In this formula, the relative impact that carbon taxes will have on a given company will be determined primarily by the company's carbon intensity, as that is assumed to be held constant in the forecast. A company with low intensity will have a relatively lower impact from carbon taxes than a company with higher intensity.

2.3 Company Adaptation

The long term time horizon involved in modelling future climate change risks on corporate companies means that it is important to consider the actions and commitments companies will take in reaction to the risks arising from a transition to a low carbon economy. Consideration of the adaptation actions is inherently challenging, as making adjustment to company's business model at a granular level far into the future is fraught with difficulties.

The assessment of company adaptation considers commitments across two separate dimensions:

1. How will a companies Adaptation Plan change their business operations mix in the future? In such cases, companies will shift their revenue generation from one technology to another.
2. How will a companies Adaptation Plan cause their GHG emissions to reduce i.e. those deemed in scope of carbon price regimes? This will reduce the overall level of carbon price costs the company will face.

This approach reflects the complex nature of adaptation plans. In some cases, companies may commit to reduce their emissions and not change their business operations mix. For example, a cement producer may continue producing cement but make the process more efficient, thereby reducing emissions but continuing with their current business model. In contrast, an Automotive Manufacturer may choose to produce more EVs and fewer ICE vehicles, but their actual manufacturing processes are made no more efficient and emissions remain unchanged. Finally, there are examples where changes to one are directly related to the other. A Power Utilities company moving towards renewable power generation like solar and wind and away from fossil fuels such as coal and gas, will both change its business operations mix, and as a result also reduce emissions. Within this assessment, one assumption is that companies do not make any further commitments from those made to date, despite the significant changes occurring in the economy. In practice, companies would have the ability to amend their business plans.

Over the last few years, an increasing number of companies have made future commitments in line with the above two categories, including short to medium term targets and longer term more ambitious goals. With such a large number of commitments and goals, across differing time horizons, the credibility of commitments and the ability of a company to meet them must be assessed. The methodology takes a conservative approach with this assessment, and sets a high bar for company plans to be considered credible. These assessments are made separately across both categories of adaptation; business operations and emissions reductions. For example, a company's ability to reduce its operational emissions may be higher than to shift business operations, or vice versa.

This credibility assessment involves reviewing and assessing company commitments including supporting evidence, documentation and evaluating the company's current position within the sector and past track record in this space. Barclays recent involvement in the Bank of England's Climate Biennial Exploratory Scenario has shaped the consideration of credibility of commitments, and the below assessment has been developed in line with this exercise's objectives and aims. Credibility considerations are distilled down to four pillars:

Pillar 1	**The company must have stated a commitment to change their business strategy, or reduce their emissions.**
Pillar 2	**The technology needed to achieve the change in business strategy or reduction in emissions must already exist in the form and at the scale needed to achieve the commitment. In addition, the company must already be using this technology internally.**
Pillar 3	**For any given commitment, the company must have in place interim targets towards meeting the overall commitment. These interim targets should be appropriate in terms of scale and speed i.e. they should not assume that rapid steps towards meeting the commitment occur near the end of the time horizon.**
Pillar 4	**The company must already be meeting or exceeding progress towards interim targets and its overall commitment. Historical evidence must be available to show this progress.**

If, and only if, a company meets the above four criteria, is the commitment deemed credible. In some cases, these questions can be addressed objectively; where a company has a 2050 net zero emissions target, and has 2030 and 2040 supporting targets separately assessed and deemed credible, it is logical to assume that they have appropriate interim targets in place (Pillar 3). However, if their 2040 target itself is not deemed credible, then it is not an appropriate interim target, and thus 2050 is not credible either. Equally, where a company has provided historic data on emission reductions between 2015 and 2020 (eg. a 10% drop over 5 years), it is logical to assume that a 20% target from 2020 to 2030 is on track given that extending their current progress would achieve this.

To support the assessment of company commitments and credibility, a number of different data gathering techniques are utilized, to both capture the target and the supporting information behind it. This aims to overcome a number of data challenges associated with this assessment:

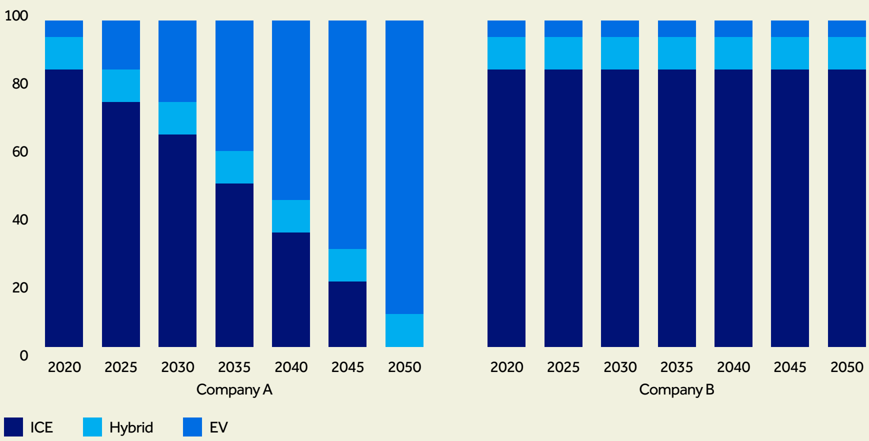
- Commitments are not stated in quantitative terms, and therefore requires interpretation as to what the most likely numeric impact those commitments have on financial metrics.
- Commitments are stated quantitatively, but not in terms that align to the methodology and/or categorization of business operations (technologies) at a sectoral level.
- Commitments do not exactly align to the assessment time periods or horizons, meaning its impacts must be interpolated to those time periods relevant to the methodology.
- Commitments have a corporate scope that is different from the entity Barclays lends to, meaning those commitments made across parts of the company's operations must be extrapolated to the relevant entity being assessed.

Data is captured both quantitatively from company commitments (in the case of numeric emission reductions) and by subjective and qualitative review of the company's disclosures, particularly where commitments focus on shifting business models. For example, where an Automotive Manufacturer credibility commits to achieve 50% of new car production in EVs by 2040, the assessment of their business model for 2040 would be based on this commitment.

The below example demonstrates the impact of adaptation in this sector, where the transition to EVs increases the demand for these types of cars, whilst ICE demand falls away. Hybrid demand initially increases before falling. Whilst overall car demand stays relatively flat, because Company A is able to adapt, it effectively protects its revenues and market share by adjusting in line with the demand for EVs, whilst Company B is unable to adapt and experiences falling market share with a significant decline in revenues.

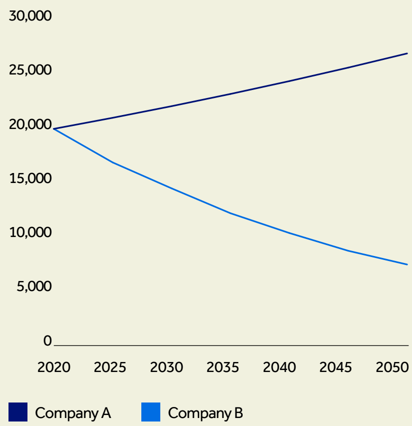
Auto OEM – Fleet Mix

%



Auto OEM – Revenue

£mn



Where companies transition their operations or implement efficiency measures, the additional capital expenditures (CapEx) required to achieve these changes are calculated as 'Proactive CapEx'. This captures company actions over and above those taken in the normal course of doing business to actively transition and mitigate climate risks. These costs are calculated separately for the two components of adaptation; companies that transition into new technologies (business operations change), and those that decarbonise their existing operations (emissions reductions).

2.3.1 Business Operations CapEx

There are three sectors of focus for calculating the shift of business operations to low carbon products and services; Oil and Gas, Power Utilities and Automotive. For the first two, it centers around costing the investment cost required to move into Renewable Power, whilst for the latter it is to ramp up production of EVs given their increase in the sales fleet mix.

For Renewable Power, the calculation considers the current level of company investment in renewable power, and then scales this up. This scaling up is both a function of the level of increase implied in the company's commitments as well as the increase implied by the projected electricity capacity for renewable power. As these increase, the supporting investment amount required will increase proportionally.

For EVs, the marginal cost of increasing the percentage of EVs in the sales fleet mix by 1% has been calculated by reviewing a sample of major Automotive Manufacturers transition plans. The resulting average marginal cost for the sector is then applied consistently to all companies. Whilst the application of an average may result in a cost being applied which differs to company commitments, given the long term nature of these commitments (10+ years) there is a strong likelihood that the amounts committed by companies today will differ from the resulting spend in reality. Creating a sector wide metric by utilizing the estimations of many Automotive Manufacturers should generate a representative cost across the whole sector, increasing both consistency of modelling and validity over time.

2.3.2 Emissions Reductions CapEx

A simple approach is used to consistently assess the investment costs associated with implementing GHG emissions efficiencies. It estimates the costs according to the size of the company based on its current emissions and CapEx intensity. Calibration of these costs was done by analyzing a wider set sectors than those considered as elevated risk, to ensure that the calculated costs were representative for elevated sectors when considering the total costs to economies to decarbonize.

1. Sectors were categorised High, Medium and Low according to carbon intensity as well as for CapEx intensity of a typical firm, indicated by the proportion of CapEx to sales at a sector level. Sectors are assigned to one of four Bands, with Band 1 being those sectors where investment costs to reduce emissions would be highest to Band 4 where they would be lowest.
2. Sample analysis of individual sectors was performed to understand the sector level investment costs required to achieve a certain level of emissions reductions at a point in time in the future. This analysis provided the marginal cost of reducing that sectors emissions by 1%. These marginal costs were then calculated as a proportion of sector level revenue, to produce a relative metric for the marginal cost of reducing emissions scaled for size.
3. This cost was then reviewed in line with other sample sectors to establish, for each Band, an average proportional marginal cost of emissions reduction. This cost, depending on the Band, could then be applied to credible company commitments, by using company revenues, sector banding and the banding percentage.

Details of the band calibration matrix, the sectors per band, as well as the costs per band, are shown below:

CapEx Intensity/ Carbon Intensity	Low	Medium	High
Low	Band 4	Band 4	Band 3
Medium	Band 3	Band 3	Band 2
High	Band 2	Band 1	Band 1

Sector	Band	Proportional Marginal Cost
Agriculture	Band 1	0.33%
Aviation	Band 1	0.33%
Cement	Band 1	0.33%
Chemicals	Band 1	0.33%
Coal Mining and Coal Terminals	Band 1	0.33%
Mining	Band 1	0.33%
Oil & Gas	Band 1	0.33%
Power Utilities	Band 1	0.33%
Shipping	Band 1	0.33%
Steel	Band 1	0.33%
Automotive	Band 2	0.10%
Road Haulage	Band 2	0.10%
Telecom Utilities	Band 2	0.10%
Water Utilities	Band 2	0.10%
Food, Bev & Tobacco	Band 3	0.01%
Homebuilding and Property Development	Band 3	0.01%
Manufacturing	Band 3	0.01%
Pharmaceuticals	Band 3	0.01%
Real Estate	Band 3	0.01%
Retailers	Band 3	0.01%
Banks and Finance Companies	Band 4	0%
Business and Consumer Services	Band 4	0%
Education, Health Care, and Not-for-Profits	Band 4	0%
Equipment and Transportation Rentals	Band 4	0%
Media, Broadcasting & Gaming	Band 4	0%

1 EBA Climate Stress Test 2020
2 Stern Business School 2020

2.3.3 Reactive CapEx

Investment costs in the form of CapEx will also change over the scenario horizon even where companies do not adapt (i.e. 'Reactive CapEx'). There is significant complexity in modelling CapEx from existing operations over a long term time horizon and therefore it requires a simplifying approach. 'Reactive CapEx' is calculated as a change in investment as revenues shift from falls or rises in market demand for goods and services. Where demand falls, it is assumed that the company will recognise that the market is declining and reduce investment expenditure, thus reducing CapEx. Where demand rises, CapEx would rise to support increases in production to meet this market demand.

When modelling investment costs, and the impact of whether a company adapts or not, a similar approach is taken to modelling revenues and costs, whereby the methodology includes a general approach for most sectors and a sector specific approach for key sectors.

2.3.4 General Approach

CapEx is broken down into three sources. First, CapEx from technologies that are deemed to increase in demand as a low-carbon transition occurs ('Low Carbon'). The second source is CapEx from technologies that will decrease in demand as a low carbon-transition occurs ('High Carbon'). Lastly, emissions CapEx measures the CapEx of any company plans to reduce their level of emissions. CapEx is linked to the future growth in demand for low and high carbon technologies.

$$Low\ Carbon\ CapEx_t = Low\ Carbon\ CapEx_{t=0} \times \frac{Revenue_{Low\ Carbon,t}}{Revenue_{Low\ Carbon,t=0}} \quad (11)$$

$$High\ Carbon\ CapEx_t = High\ Carbon\ CapEx_{t=0} \times \Delta_{High\ Carbon,t} \quad (12)$$

Emissions CapEx is assessed based on a company's projected revenues, the average unit cost of abatement (estimated at sector level) and the projected abatement:

$$EmissionsCapEx_t = Revenue_t \times Band_{sector} \times (Abate_t - Abate_{t-1}) \times 10 \quad (13)$$

Total CapEx is the summation of the above three individual sources of CapEx. There is an assumption that part of CapEx will be financed partly by debt issuances and partly by equity issuances:

$$CumulCapExChanges_t = \sum_{t=1}^{T} (TotalCapEx_t - TotalCapEx_{t-1}) \quad (14)$$

$$NetDebt_t = max\ (NetDebt_{t=0,}0) + CumulCapExChanges_t \times CapExMultiplier_s \quad (15)$$

The cumulative sum of CapEx Changes is multiplied by the CapEx Multiplier, which represents the portion of CapEx that is funded by net debt, and added to the starting net debt figure. Net debt is floored at zero, to disallow any negative net debt figures for conservatism.

2.3.5 Oil & Gas Approach

For the Upstream sector, CapEx is reduced by a scalar as shown below.

$$CapExUpstream_t = CapEx_t \times (1-1_{scen} \times 0.5) \quad (16)$$

The adjustment considers that in scenarios where the market is known to be structurally declining, companies will no longer pursue new investment opportunities to replenish reserves. As such, those CapEx costs associated with new developments, in this case simplistically calculated as half of total CapEx, will be reduced as the company focuses on maintenance costs in a run-down scenario.

2.3.6 Power Utility Approach

For companies with non-credible plans, CapEx is given below.

$$High\ Carbon\ CapEx_t = High\ Carbon\ CapEx_{t=0} \quad (17)$$

$$Low\ Carbon\ CapEx_t = Low\ Carbon\ CapEx_{t=0} \times \frac{Revenue_{Low\ Carbon,t}}{Revenue_{Low\ Carbon,t=0}} \quad (18)$$

CapEx here is held flat for fossil fuel technologies (i.e. high carbon technologies), in line with the approach for Revenue as in equation (6). For renewable technologies, CapEx is linked to the growth in revenues in those technologies. Specifically, as demand for electricity increases, Regulated Power Utilities who enjoy a monopolistic position for the regions they serve, will be required to increase their provision of power to meet increasing demand. This will require additional sources of generation and additional CapEx to develop these new assets.

For companies with credible adaptation plans, CapEx is given below.

$$High\ Carbon\ CapEx_t = High\ Carbon\ CapEx_{t=0} \times \frac{Revenue_{coal+gas,t}}{Revenue_{coal+gas,t=0}} \quad (19)$$

$$Low\ Carbon\ CapEx_t = Low\ Carbon\ CapEx_{t=0} \times \frac{Revenue_{renewable,t}}{Revenue_{renewable,t=0}} \quad (20)$$

$$OtherCapEx_t = Other\ CapEx_{t=0} \times \frac{Revenue_{nuclear+non\text{-}relevant,t}}{Revenue_{nuclear+non\text{-}relevant,t=0}} \quad (21)$$

As can be seen in (19), (20) and (21) above, CapEx for each technology is driven by the corresponding revenue growth in that technology.

2.3.7 Automotive Approach

For companies without adaptation plans, CapEx is forecasted to grow in line with respective revenues. For companies with adaptation plans, CapEx is split by Proactive CapEx (including the marginal cost of increasing the percentage of EVs in the sales fleet mix by 1%, shown in the following equation as ρ) and Reactive CapEx (growth in market auto demand). The equations are given below.

$$Proactive\ Capex_{Low\ Carbon,t} = Low\ Carbon\ CapEx_{t=0} \times BusSplit_{Low\ Carbon,t=0} + CapEx_{t=0} \times \rho \times \Delta BusSplit \quad (22)$$

$$Proactive\ Capex_{High\ Carbon,t} = High\ Carbon\ Capex_{t=0} \times \frac{Revenue_{High\ Carbon,t}}{Revenue_{High\ Carbon,t=0}} \quad (23)$$

$$Total\ Reactive\ Capex_t = Total\ Proactive\ Capex_t \times (\Phi_{AutoDemand,t} - 1) \quad (24)$$

Total CapEx is then computed as the sum of Total Reactive and Total Proactive CapEx.

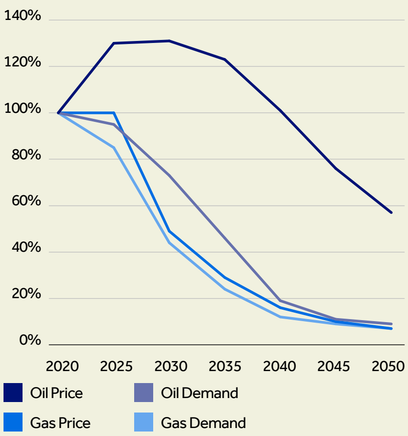
3 Financial and Credit Risk Outputs

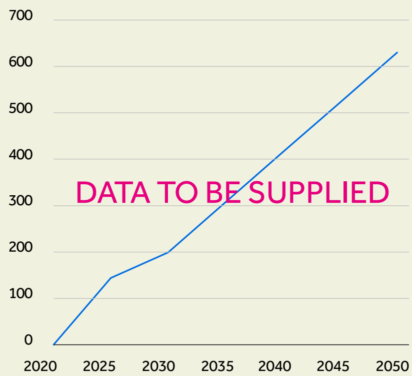
3.1 Financial Impact

These building blocks are assessed in combination to forecast the future financial performance of a company. To illustrate this, a range of pairwise example companies within the Oil & Gas sector are presented below, where the outcomes of the modelling vary on the relative calibration of key design choices outlined in section 2. All examples assume a transition occurs imminently and in an orderly fashion, and show indexed earnings (EBITDA) to demonstrate relative impacts.

Scenario Variables: *Orderly NCFS Scenario*

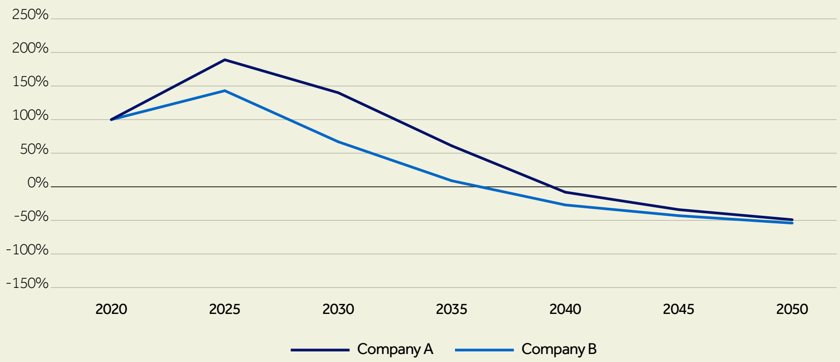
The below graphs oil & gas price and demand curves in index form, alongside the carbon price curve showing £ per tonne of CO2e





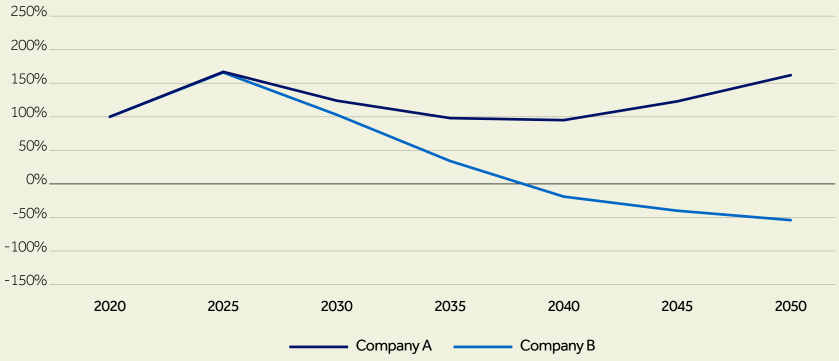
Example 1: *Oil company vs Gas company*

In this example, Company A operates predominantly in Oil with revenues dominated from the sale of Oil based products. In contrast Company B is focused on Gas with a majority of revenue from this commodity. In this example, the scenario causes a divergence immediately as Oil prices are forecast to recover post COVID, leading to higher revenues for Oil sales. In addition the scenario forecasts that Gas as a commodity declines in demand more rapidly than Oil, leading to earnings declining more swiftly for Company B. However, in both cases, the structural decline in demand for fossil fuels leads to negative earnings for both companies in the long run.



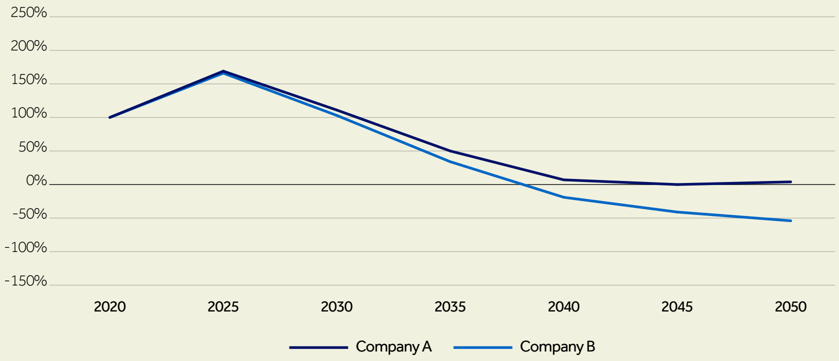
Example 2: *Company moves to renewables vs Company does not adapt*

In this example, Company A makes the strategic decision to shift away from fossil fuels and towards renewable power as its main source of revenue generation. In contrast Company B does not make this transition and focuses instead on competing in the fossil fuel space. At the start of the scenario the impact of this is minimal as Company A has not yet transitioned a large portion of its business operation towards renewables, nor has the demand for renewable power increased substantially. However from 2030 onwards, a clear divergence occurs where Company A is able to drive new revenue generation from renewables and increase earnings, whereas Company B suffers from declining demand and resulting falling earnings.



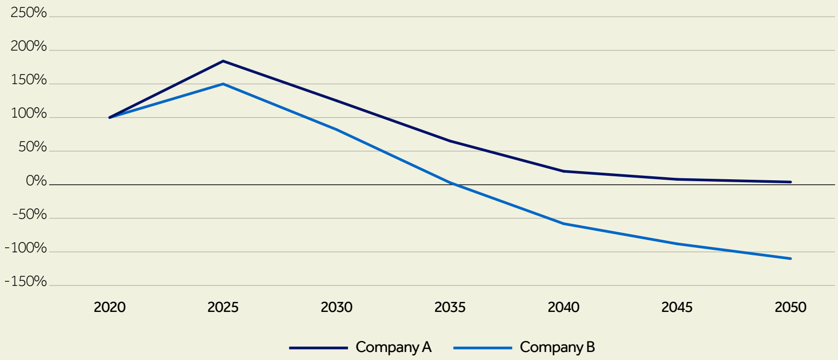
Example 3: *Company pursues emissions abatement vs Company does not act*

In this example, Company A pursues initiatives to reduce it's GHG emissions, through new technology and efficiency measures, leading to net-zero scope 1 and 2 emissions by 2050. In contrast, Company B does not invest in these measures and their emissions remain high throughout the scenario. Despite these changes in emissions profiles, the resulting impact on company performance is muted, as structurally declining fossil fuel demand has an overwhelmingly negative impact on the companies earnings, In addition, this graph of earnings does not indicate the additional investment costs faced by Company A to achieve these reductions, which may lead to greater debt and leverage.

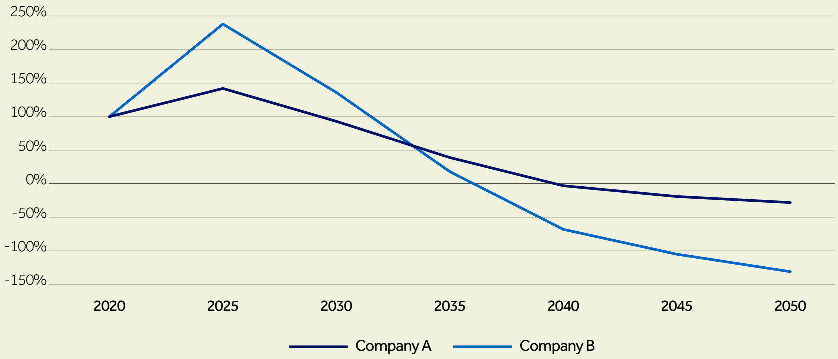


3 Financial and Credit Risk Outputs continued

Example 4: ***Company passes through carbon taxes vs Company unable to pass through***
In this example, Company A is able to pass through to the end consumer the majority of the additional costs associated with carbon taxation. In contrast Company B is unable to pass these costs through. The driver of these differences is varied, but could include for example the geographic jurisdiction in which the company operates, as well as the companies starting cost efficiency eg. a lower cost per barrel versus peers. In addition, the relative carbon emissions intensity of the companies operations may lead to difference in their capacity to pass through costs. Companies with lower carbon intensities will face lower relative carbon taxes, and thus be better able to pass through a higher proportion of their carbon taxes compared to their current sales.



Example 5: ***Company with high starting profit margins vs Company with low starting profit margin***
In this example, Company A has a higher starting profit margin for a given level of revenue vs Company B. This implies that Company A has a lower level of costs for its operations than company B. This leads to Company A being able to generate positive earnings longer into the scenario than Company B given it's stronger starting financial position that can better withstand the introduction of carbon taxes and declining demand for fossil fuels. Whilst both companies end up with negative earnings by the end of the scenario, the flatter curve of Company A implies lower volatility in its earnings and thus lower level of risk throughout the scenario.



3.2 Credit Assessment and Scorecards

The final assessment step involves translating financial impacts from future climate scenarios into credit metrics that can be used to assess the company's future credit quality. As with calculating financial impacts, the long term time horizon creates significant challenges in calibrating a credit metric. These challenges include existing credit models using a large number of variables to calculate credit output, but where the ability to make these variables at future time points is currently not feasible. In addition, these models include factors which are not necessarily impacted by climate change, and thus the understanding of climate change risks on credit standing may be hidden by less relevant factors.

As a result, a scorecard has been developed to assess the impact of the climate adjusted financials on credit rating. This allows us to better understand the impacts from climate change, without incorporating additional dynamics from complex and probabilistic modelling that pose challenges when evaluating how climate risks drive credit impacts.

The approach includes three key rating factors and metrics:

Factor	Metric	Rationale
Scale	**Revenue**	**Scale allows for analysis of company's ability to withstand negative impacts arising from climate change, as a result of greater financial resources. Their greater size is often correlated with increased diversification, both geographically and sectorally, which provides a bulwark against negative climate risk impacts.**
Profitability	**Revenue/Gross Profit**	**Companies with greater profitability are better positioned to absorb the increased costs that climate change risks can cause; those companies with low profitability may find the impact of climate change can push them into a negative financial position very quickly. In addition, in analysing intra-sector, companies with greater profitability in competitive industries will likely outcompete others, allowing for analysis of winners and losers from climate change.**
Leverage	**EBITDA/Net Debt**	**Leverage allows for an analysis of the company's ongoing viability as it relates to:** **1 The ability of the company to support its existing long term debt, as climate change risks impact financial performance** **2 The ability of the company to fund increased investments to transition to a low-carbon economy**

These factors are readily available outputs from the financial impact assessment. Additional non-quantitative factors, such as the company's business model and financial policies were considered, however it was deemed that such considerations would be captured when the outputs of the assessment are reviewed by subject matter experts, and where these factors would materially change the outcome, they would be incorporated at that stage.

The mapping of financial metrics to credit ratings for each factor is calibrated based upon the observable population as of today, including existing company's financial ratios and the associated company credit rating. This allows for a scale to be established, for each factor within each sector, which in turn provides the foundation for future assessments as company's financial metrics change.

These rating factors are then weighted to produce a final credit output, and the weighting assigned to each is sector dependent. This reflects the fact that certain sectors exhibit greater reliance on one factor or another when determining credit rating. The calibration of these weights has considered both current importance of the factor in a sector credit assessment, but also likely future assessments of credit. This reflects the fact that for many sectors, carbon price costs are not a material consideration at this time, and so factors such as Scale (total revenues) may currently play an outsized role in determining credit strength. However, in the future it is likely that companies less exposed to carbon pricing, through lower emissions, will be better positioned, and therefore erode the outsized influence of the Scale factor. An example of this would be in the Power Utilities sector, where currently the scale of a company is one of the most material factors. However, under scenarios which include significant carbon taxes, such scale, if accompanied by associated large emissions, may work in the opposite direction and cause rating deterioration as carbon costs increase. Whilst such changing dynamics may be challenging to forecast, it is important that assessments are made sensitive to how credit rating methodologies may evolve as climate risks materialize.

The calculation of credit rating, using Barclays DG scale, is as below, where α is the weight on each factor, for a given sector.

$$Modeled\_DG\_t = DG\_(levg,t) \times \alpha\_levg + DG\_(profit,t) \times \alpha\_profit + DG\_(scale,t) \times \alpha\_scale\ \Delta ModeledDG\_t \quad (24)$$

This is calculated for all periods in the forecast, as well as the jump-off point. The model then calculates the delta from the prior period in the modeled DG score, applies the delta to the actual jump-off DG score from Barclays existing credit systems.

$$\Delta ModeledDG\_t = ModeledDG\_t - ModeledDG\_(t-1) \quad (25)$$

$$DG_t = DG_{t-1} + \Delta ModeledDG_t \quad (26)$$

The approach taken here is in line with the methodologies aim to capture directionality and magnitude of impact over a long term time horizon rather than a very specific degree of accuracy. There are limitations to such an approach, including that the DG produced by the model methodology may differ to the actual DG on a spot basis, driven principally as outlined above by the variety of factors the scorecard does not account for currently.

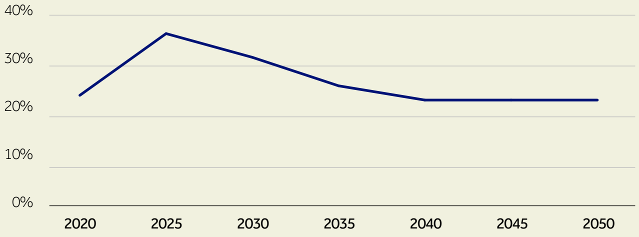
The below example shows the ratings progression for Company A and B in Example 2 in section 3.1. For the Oil & Gas sector, the weightings for the scorecard components are as follows:

Factor	Metric	Weight
Scale	Revenue	36%
Profitability	Revenue/Gross Profit	18%
Leverage	EBITDA/Net Debt	46%

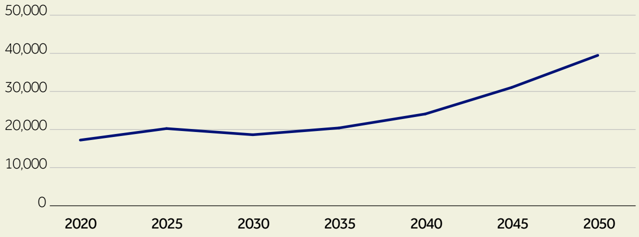
Example 2 continued: ***Company A***

In this example, Company A makes the strategic decision to shift away from fossil fuels and towards renewable power as its main source of revenue generation. The initial increase in Oil Prices at the start of the scenario leads to improved financial metrics and an improvement in credit grading. As the scenario progresses and the company transitions to renewables, these new streams of revenue replace fossil fuels bases revenues driving improvements in the Scale metric. The Leverage metric deteriorates in the middle of the scenario as the firm enacts its transition plans, causing increased capital expenditure and resulting increase in net debt.

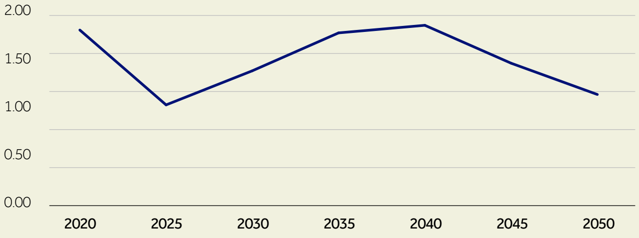
Profitability



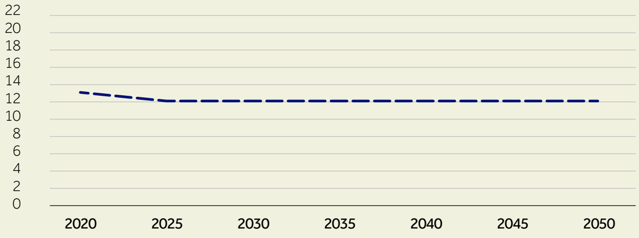
Scale (£mn)



Leverage



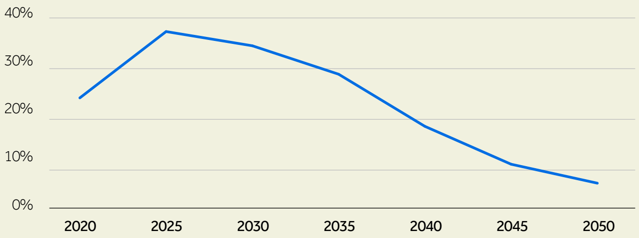
DG



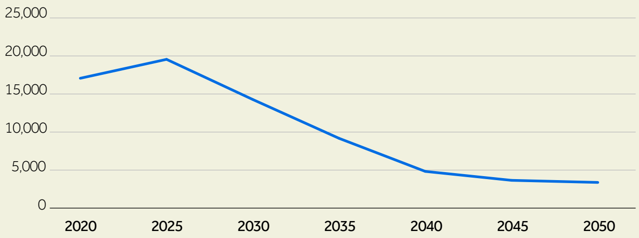
Example 2 continued: ***Company B***

In this example, Company B does not transition into renewable power generation, and focuses instead on competing in the fossil fuel space. Whilst the initial increase in Oil Prices causes improvements in the financial metrics, resulting in an improved credit rating, the rapid increase in carbon prices and the falling demand for fossil fuels causes significant declines in the Scale and Profitability metric, whilst Leverage increases before turning negative as earnings fall below zero. These factors drive a declining credit rating, leading to the company defaulting in 2040.

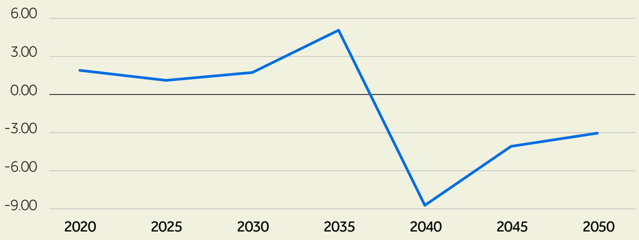
Profitability



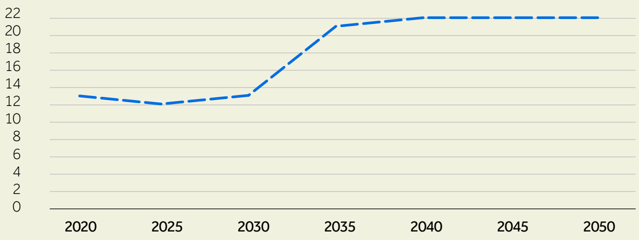
Scale (£mn)



Leverage



DG



4 Known Enhancements

The approach is intentionally simplistic, recognizing that modelling the financial performance of companies over a long term time horizon is inherently fraught with issues and methodological challenges. Focus has been on achieving directionality and magnitude of impact rather than accuracy. To that end, a number of assumptions are designed to identify potential winners and losers, rather than the specific credit rating of a company. There are however a number of areas of known enhancements to consider in the future to improve the performance of the methodology and better identify and quantify risks.

4.1 Data

The most significant limitations with the methodology stem from the lack of consistently available input data. This is an issue spanning multiple data types and sources, but is most acute in terms of financial data and emissions.

4.1.1 Financial Data

The methodology follows a consistent approach across a wide breadth of sectors and large depth of the company types within those, and therefore it seeks to use consistent data types and formats, which may not be available for all companies. For example, within Oil and Gas, cost of sales data is a less relevant metric for certain value chain participants (eg. Upstream) and therefore it is challenging to obtain a meaningful metric or estimation to integrate into the methodology. Alternatively, in the case of smaller private companies, the suite of financial metrics produced may not include those required to perform modelling.

Attributing revenues to specific technology types presents issues given that this data is rarely disclosed in the format required. Various estimation techniques are utilized to derive this information however there are limitations to these approaches. For example, in the Power Utilities sector, the type of generation fuel (eg. coal vs renewables) is not directly linked to the generation of revenues, and therefore it is less clear the direct impact a reduction in demand of one technology type will have to revenue.

Finally, given the methodology uses jump-off values to forecast future impacts from climate scenarios, it is change to: sensitive to the magnitude of these starting values, that are unrepresentative of the long run financial performance of the company eg. the impact of COVID-19. When considering a long term time horizon, a representative starting position for the company is required from which the impacts of climate change can be isolated. Using running averages as a starting point may enhance the representativeness of the jump-off, to ensuring it is a fair reflection of the company prior to climate scenarios being applied.

4.1.2 Emissions Data

In order to calculate the impact of carbon prices to companies, accurate GHG emissions data is required. Carbon taxes represent one of the most material drivers of transition risk and therefore accuracy of emissions is important. Certain sectors however, and in many cases smaller companies, are less prone to disclose their emissions data. In such instances, the methodology estimates emissions using sector level financial intensities. This approach may lead to discrepancies between emissions utilized by the methodology and those emitted in reality, leading to punitive or favorable carbon taxes and financial impacts that may be less accurate.

4.2 Modelling Production Vs Revenue

The segmentation and attribution of company revenues to technologies, and the subsequent modelling of those revenues over time depending on changes in relevant scenario variables, can cause modelling issues. In particular, there are challenges when considering the interaction between changing market dynamics through scenario variables and company specific actions through adaptation plans. Calculations of future financial performance where the number of assessment dimensions increase (i.e. starting financial performance, scenario variables and company business operations) becomes challenging as there are feedback loops and interactions between them that are not easily isolated. Future enhancements may consider moving the modelling approach to focus on production metrics rather than revenue generation, to assess revenues sequentially rather than as a sensitivity. Further work is required to understand the conceptual requirements for such an approach, as well as the availability of data that would support this form of modelling.

4.3 Incorporating Different Margins

The approach currently considers profit margins to be static. Costs are modeled as changing in line with revenues, which in turn causes margins to stay the same. The one exception to this is for Oil & Gas companies where the approach allows an improvement in margins once the transition begins, reflecting past experience where such companies implement cost savings to improve margins in adverse economic climates. In the future, dynamic margins may be considered and at a lower level of granularity i.e. sector, sub-sector or company specific.

4.4 Adaptation Sensitivity

Over a long term time horizon, the actions taken by a company can materially impact the outcome of the assessment. The adaptation assessment only considers current plans and treats them as either credible or not credible using the credibility criteria outlined. This binary decision however ignores that in many cases, companies will endeavor to meet their commitments, and even in instances where they do not achieve the desired goal, they will have made positive steps to either reduce emissions or transition to low carbon products or services. These improvements would not currently be factored into the methodology and may cause more severe impact assessments than would likely occur. Possible enhancements to this include consideration of adaptation on a sliding scale, where plans may be considered fully credible and factored in, plans may be considered not credible (in cases where there are aspirational statements only and no supportive evidence) or partially credible, where the plan is discounted in some manner to consider that part of the plan is achieved but not the full commitment. Further enhancements for consideration include how to factor in that companies may change business plans over time further than current commitments as economies transition and risks and opportunities from climate change materialize.

4.5 Credit Output

The conversion from financial impact to credit impact utilises a simplistic scorecard across three factors. This is representative of the inherent challenge of calculating credit impacts over such a long term time horizon. The current factors are quantitative in nature, using financial metrics which are produced from the methodology. Additional qualitative factors may be considered in a review process after the run, but are not currently factored into the scorecard calculation and such factors can be significant in a number of sectors. One example would be the level of Regulatory support and cost recovery ability for Regulated Power Utilities. In addition, the contribution of factors to the overall credit score are weighted at a sector level using SME judgment. These weights are subjective and may not be appropriately calibrated to represent the sectors key credit considerations. Finally, the credit rating outputs may be reviewed to consider simplifying the range of outcomes, away from specific credit ratings and to credit rating buckets i.e. Investment Grade vs Non-Investment Grade. Non-Investment Grade and sub-categories of these.

4.6 Geographical Granularity of Data

The methodology currently uses scenario variables and their impact to companies at a global level and does not differentiate between country level dynamics i.e. demand for certain goods and services may differ from one country to the next. This is also true of carbon price where a global carbon price is assumed rather than one set at a country or regional level. The necessary company level data required to apply geographical granularity to the assessment is currently too onerous and in many cases not available to support modelling.

4.7 Demand Sensitivity

Changes in scenario demand for products and services is currently treated as uniform across all companies with operations in that technology. For example, a 20% fall in demand for cement would impact revenues for all cement companies to the same magnitude. However, a fall in demand for products and services is likely to impact different companies to different extents, with some more sensitive to a fall whilst others will remain insulated. This may be a function of the operational efficiency of a company, slight differentiation in product offering or geographical considerations, amongst others. Enhancements may consider how to incorporate this sensitivity to demand into the model, and to this end initial assessments have been undertaken for companies in the Oil & Gas sector, where certain factors of a company (eg. size) be considered as an indicator of how scenario demand would translate to company demand.

4.8 Stranded Assets

The methodology currently focuses on changes in revenues and costs i.e. income statement metrics, rather than on balance sheet items such as assets. Changes in the demand for fossil fuels, and the reduction under transition risk scenarios, may cause the value of company assets to change and in some cases fall eg. stranded oil reserves for oil & gas clients. These changes in assets may in turn cause companies to suffer financial deterioration which would drive higher credit risk, which the approach does not currently factor in.

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