CARBON ASSET RISK ASSESSMENT FRAMEWORK

Among the many challenges relating to climate risk management is the question of identifying and assessing exposure to Carbon risk. Indeed, Carbon risk could affect a wide range of physical assets and businesses. In fact, the possible exposure of a financial intermediary or investor to carbon asset risk is real and can be assessed through analysing information on the underlying carbon risks of the operators with whom they have a financial relationship. Assessing exposure at the company level is necessary in addition to broad sector-level screening. Because of their distinct characteristics, operational conditions and management strategies, organisations, even those in the same sector or industry, can have vastly varying risk exposures.

This article describes a framework to determine carbon risk exposure by describing the sectors and physical assets concerned as well as examples of measures that could be useful in practice. Financial intermediaries and investors can use this approach to frame and conduct in-depth risk analysis. There is no one-size-fits-all priority list due to the range of sector categorisations, local regulatory frameworks and time horizons applicable to different financial institutions and investment classes. As a result, this paper aims to propose a simple and clear process to design and implement a carbon asset risk assessment framework.

IDENTIFYING CARBON RISK SECTORS AND COMPANIES

Carbon risk can affect a wide range of physical assets and companies, but those involved **in the production of fossil fuels, fossil-fuel-fired power plants and infrastructure** that is largely reliant on fossil fuels **attract the most attention**:

- ✓ **Fossil assets** are physical assets in industries like **coal mining and oil and natural gas extraction.** The key challenge lies in the fact that experts believe the 2°C scenario won't be enough to reduce growth of such assets in developing countries in the shorrt term. In the long run, demand for these assets is likely to decrease as a result of policy measures that reduce consumption and subsidies or increase taxes on products and production.
- ✓ **Fossil-fuel dependent infrastructure** refers to assets that rely on readily available, **low-cost fuels for transportation**. Climate and energy policy may have an impact on the changes projected in these sectors, as well as the degree of investment in these areas. Furthermore, there is no agreement on how technology will evolve or what impact such trends will have on the value of infrastructure.
- ✓ **High-carbon assets** for which **alternative, low-carbon technologies exist** and are projected to eventually replace more carbon-intensive technologies are referred to as high-carbon assets facing a shift to low-carbon technologies. Direct policies like carbon taxes and energy consumption taxes, as well as more strict regulatory requirements like energy efficiency standards, could have an impact on these industries.
- ✓ **High-carbon assets without low-carbon competitors** is a category that includes industries for which there is currently no established low-carbon technology. However, the implementation of climate policies, as well as the ultimate emergence of alternative technologies, may have an influence on their business.

Each of these categories are made up of industry sectors whose companies may have activities, products and services that may be exposed to carbon risk. In fact, the financial assets associated with these companies may generate different exposures to carbon risk depending on the nature and speed of the transition adopted towards a low carbon economy. The table below is tempting **to summurise these interactions.**

Sectors (Example)		Principal Types of Risk facing the Category				Typical Financial Asset Classes			
		Policy	Market	Tech.	Reputat.	Equities	Bonds	Corp. Lending	Project Lending
Fossil-fuel assets	• Coal mining; • Oil and gas production	√	√	√	√	√	√	√	x
Fossil-fuel dependent infrastructure	• Airports • Fossil-fuel pipelines • Electric transmission • Rail lines	√	√	x	√	x	√	x	√
High-carbon assets facing shift to low-carbon technologies	• Fossil fuel-fired power plants	√	√	√	x	√	√	√	x
High-carbon assets without low-carbon competitors	• Cement • Steel • Gas	√	√	√	x	√	√	√	x

ASSESSING EXPOSURE TO CARBON RISK AT THE SECTOR LEVEL

For each key sector potentially affected by climate and energy policy risks, **three key indicators related to carbon asset risk** have to be taken into account:

1. **SECTOR CARBON INTENSITY OF SALES**

Carbon intensity expresses the carbon efficiency of the portfolio and allows institutional investors to measure the volume of carbon emissions per dollar of sales generated by portfolio companies over a specified time frame. It is calculated by dividing the portfolio's total carbon emissions (apportioned by the investor's ownership share) by the portfolio's total sales over that same period (apportioned by the investor's ownership share).

Hereafter is described a practical example.

	Portfolio Position	Total Market Cap	Ownership %	Company Carbon Emissions	Portfolio Carbon Emissions	Company Sales	Portfolio Claim on Sales (% Owned * Sales)	Portfolio Carbon Intensity (Total Emissions / Total Sales)
Firm 1	1 000 000	20 000 000	5%	10 000 tCO2e	500 tCO2e	50M	2,5M	
Firm 2	5 000 000	50 000 000	10%	25 00 tCO2e	250 tCO2e	30M	3M	
Total					750 tCO2 e		5,5M	136 tCO2 e /M

2. **PHYSICAL ASSETS LIFESPAN**

The useful life of an asset is an estimation of the **length of time the asset can reasonably be used to generate income and be of benefit to the company.** The useful life of identical assets varies by user, and that life depends on the asset's age, frequency of use, condition of the business environment, and repair policy. Additional factors that affect an asset's useful life include anticipated technological improvements, changes in laws and economic changes.

3. **EBIT MARGIN**

An **EBIT Margin** is the **operating** earnings over **operating** sales. This **margin** allows investors to understand true business costs of running a company, because parts of a company's property, plant, and equipment will eventually need to be replaced as they get used, broken down, decayed, etc.

The indicators are applied **to each key sector potentially affected by climate and energy policy risks**. The connection between each metric and potential risk is clear:

- Sectors that are large GHG emitters or that are very carbon intensive, all else being equal, generally **face exposure to greater risk from a potential carbon price or direct regulation**, because the increased cost would represent a higher proportion of cost structure;
- Sectors with **higher average physical asset lifespan**, all else being equal, **generally face exposure to greater risk because of longer exposure periods; and**
- Sectors **with lower EBIT margins**, all else being equal, generally **face exposure to greater risk, because any increase in costs is likely to have a larger impact on profitability**

PHYSICAL ASSET FUNDING: THE CAPITAL STACK

The total amount of capital spent in a physical asset or company is referred to as the "Capital stack." Awareness and analysing carbon risk exposure requires an understanding of **where money stands in the stack**. Debt, loans, bonds and equity are the **main types** of financing used to fund carbon assets. Debt has a higher position in the capital stack than equity, which means it is repaid first and has lower risk (and returns) than equity. Commercial and investment banks typically make loans and may also underwrite debt and equity instruments, which investors subsequently purchase and hold. The type of financing given, the length of the loan or investment and whether it is secured by collateral all have an impact on the risk and return profile of a loan or investment. These are **all significant factors to consider when assessing potential exposure to CAR.**

The table below describes **the key process of each instrument to finance physical assets.**

Categories	Type of Capital	Physical asset or company level	Type of Investments	Type of intermediaries and investors	Service providers
Equity	• ECM • Private equity	• Stocks, private equity • Private and public equity	• Ownership, through direct holdings of shares or through funds	• Institutional investors • Retail investors	• Banks • (underwriting) Asset managers
Debt (Bonds)	• DCM • Private placements • Project specific bonds	• Corporate bonds • Project bonds	• Lending (borrow-ing), through direct holdings or bonds or through funds	• Institutional investors • Retail investors	• Banks • (underwriting) Asset managers
Debt (Loans)	• Corporate loans • Project finance loans	• Corporate loans • Project finance loans	• Lending through direct loans or through a lending syndicate (multiple lenders)	• Banks • Institutional investor	• Banks (lenders)

If a financial intermediary has determined that an underlying physical asset or company is exposed to carbon risk, the next step is to determine **whether that translates to potential carbon asset risk**. Scenario analysis and stress testing are used to assess how risk factors (that is, policy, markets, and technology) **might evolve over time** and what **the financial impact could be**. Such analysis can be performed **in two ways**:

- **A bottom-up approach, at the operator/ company level, or at a financial portfolio level**, focusing on how risk factors affect a diversified portfolio of investments. The operator/company approach applies scenarios to institutions and their physical assets, evaluating the financial impact of assets using **valuation methodologies such as discounted cash flow (NPV, IRR, Break-even price).**
- **A top-down, portfolio-level approach** is also an option for investors. Risk factors are found through scenario analysis, much as they are in a bottom-up strategy, but these risk factors are then utilised to quantify overall portfolio exposure and potentially, to optimise asset allocation based on which scenario is thought to be the most likely.

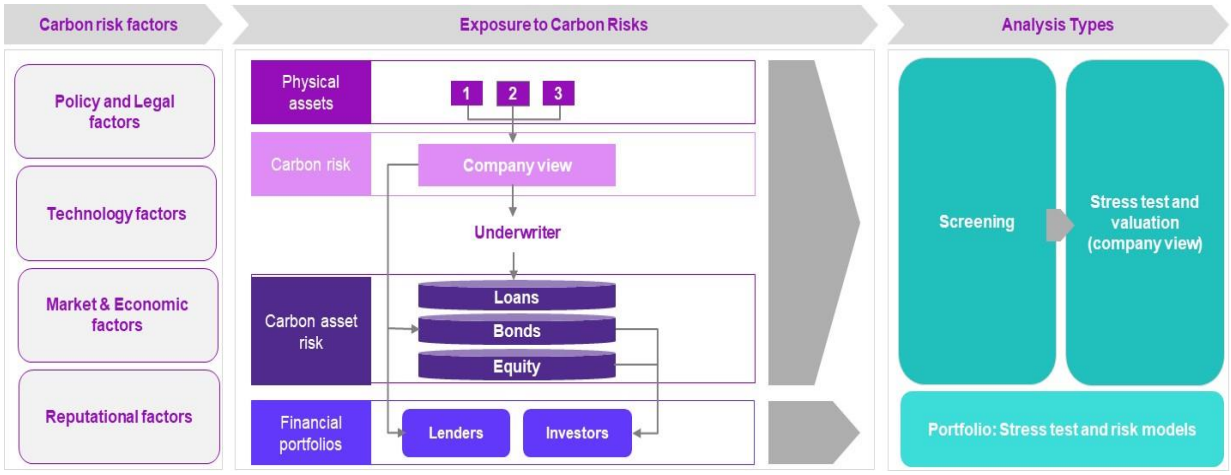
CARBON ASSET RISK ASSESSMENT FRAMEWORK

Before going into a method for evaluating carbon asset risk, it is important to go over **the primary points covered in the preceding sections.**

- ✓ **Identifying carbon risk in sectors and companies** focuses on factors that can affect the degree to which different types of assets, sectors and operators/companies are sensitive to carbon risks. Carbon intensity, physical asset lifetime and earnings margins are among them. It is also crucial to examine pricing power (or demand elasticity) at the company level, as well as the unique characteristics of its assets and operating environment, including how the operator/company strategically manages its carbon risk exposure.
- ✓ **The funding of physical assets called 'Capital Stack'** examines risk exposure in the context of various forms of capital (such as loans, bonds, and equities) in the "capital stack." It defines general principles that are crucial when assessing the materiality of carbon asset risk for different types of capital and financial actors.
- ✓ Then, **screening carbon risk exposure**, starting from the physical assets owned by companies (carbon risk). Carbon asset risk exposure to investors and financial intermediaries at various levels of a firm can vary a lot based on the diverse asset portfolios at these various levels, depending on the form and type of financial relationship, and location in the capital stack.
- ✓ The next stage is to examine **the potential financial impact using risk and value models**, either at the asset or operator/company level or at the portfolio level, for those assets or operators/companies that are exposed to carbon risk.

HIGH-LEVEL OVERVIEW OF THE CARBON ASSET RISK ASSESSMENT FRAMEWORK

The following figure describes a Carbon risk assessment framework **through a linear process**:

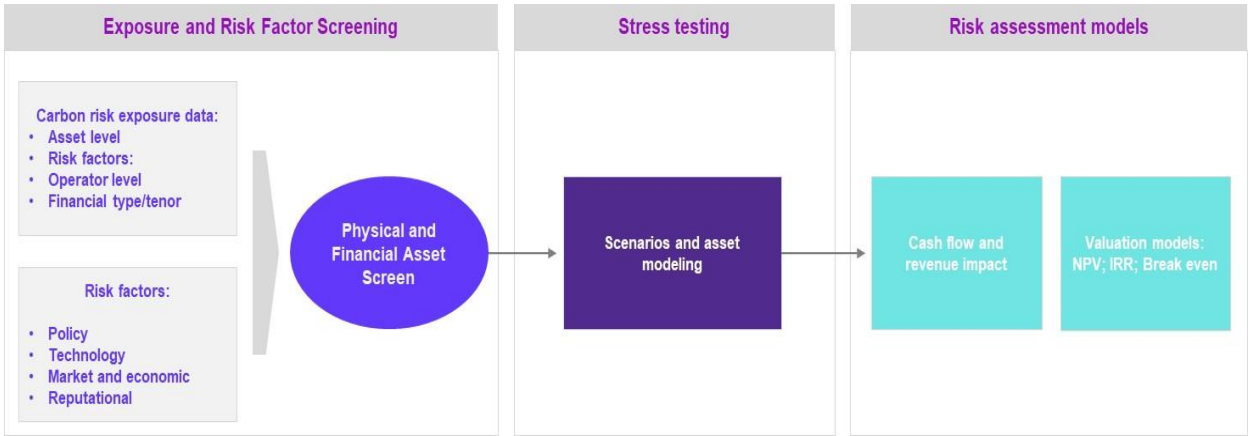


It follows the described steps:

1. Identification of relevant **carbon risk factors;**
2. Screening **carbon risk exposure;**
3. Carbon risk and Carbon asset risk vary at different levels, depending on the different asset portfolios
4. For those assets or operators/companies **facing carbon risk exposure**, the potential financial impact is assessed using **risk and valuation models, either at the operator/company level or the portfolio level.**

I. A BOTTOM-UP APPROACH TO ASSESS CARBON ASSET RISK (COMPANY LEVEL)

The following figure below provides an overview of the key steps of bottom-up approach to assess carbon asset risk at the company level.



These three steps are described in more details below.

1. EXPOSURE AND RISK FACTOR SCREENING

Because analysis should focus on investments with the largest potential exposure, screening is critical. The first step in evaluating an underlying operator/company is to **identify and evaluate critical exposure data and risk factors**. A review of qualitative and quantitative data reported publicly by a corporation, an ESG information source and/or releases could be part of this screening.Pertinent data and information can be classified **into three main categories**:

i. **Company** and **physical asset-level** information;

Screening at the operator level considers **two types of information**:

- ✓ The **characteristics of the operator's portfolio** of physical assets (type of assets, expected lifetime…)
- ✓ The **operator carbon strategy** (e.g. cost of production, GHG emissions profile of the assets…)

ii. **Type and duration** of the financial relationship

It includes the type of financing and investments and associated characteristics (expected duration and liquidity).

iii. **Baseline scenario data**

Then, it is important to consider macro-scenario data during the initial screening process which will provide the context in which the analyst can understand how **risk factors** (policy, market, technology) are **most likely to change over time at a macro level** and thus how assets and operators **are likely to be affected within that context.**

iv. **Screening: synthesizing the results**

When determining whether a particular type of financing or investment warrants further investigation, it is critical to look beyond static or backward-looking data and information and consider **how operators/companies might appear in the future**, particularly in timeframes when carbon risk factors may manifest. A financial intermediary or investor should gain a better understanding of the **operator/governance company and its operating strategy**, **potential future demand for its product(s)** and how its **portfolio of physical assets may change** in the future in order to develop a more realistic understanding of the impacts of carbon risk on a loan or investment.

2. MACRO-SCENARIOS

Following the risk factor and exposure screening, the primary focus is on scenario analysis and stress testing using broad economic frameworks based on exposure and risk factor screening. Such methods use **scenarios to assess supply and demand** and create data such as predicted cash flow implications, which are then used to build valuation models. Regarding carbon asset risk assessment, scenario analysis provides a useful way **to understand the financial implications of potential policies, regulations and market forces** that might impact the financial intermediary or investor.

Carbon risk factors can be seen as either **an extension of current trends ("current risks"), or as more uncertain "event risks," which stem from unpredictable policy or market changes**. Useful information is available from many entities, such as the IEA, think tanks like the Carbon Tracker Initiative, investment analysts and other commercial tool providers.

In this context, IEA's World Energy Outlook is a **good starting point for long-term scenario data** as this model:

- Is comprehensive in terms of **macroeconomic variables and energy sector information**, allowing all of the economy's demand and supply dynamics to be combined;
- Can be used **to examine Carbon asset risk at multiple levels**, starting with a single investment and progressing to an asset class, portfolio and industry;
- **Include several scenarios** based on major assumptions about the global economy, energy system and policies in the future;
- **Provide a "prediction" of future energy demand and supply** on a worldwide scale as well as within specific regions, countries, and industries. The important scenarios for the years 2040 and 2050 are listed here.

Overview and descriptions of the key scenarios of World Energy Outlook and 2DS.

Current Policies Scenario	New Policies Scenario (NPS)	450 Scenario	The 2°C Scenario (2DS)
• A scenario that assumes **no changes in policies from the mid-point of the year of publication** • Previously called the reference scenario	• A scenario that takes account of **broad policy commitments and country commitments**, including: ✓ National pledges to reduce GHG ✓ Plans to phase out fossil-energy subsidies • This broadly serves **as the IEA baseline scenario**	• A scenario that sets out an energy pathway consistent with the Paris agreement (limiting the average global increase in temperature to 2°C and the concentration of GHG in the atmosphere to around 450 ppm of CO2. • This scenario assumes considerably **more climate mitigation and thus lower fossil-fuel demand**	• Energy system consistent with an emissions trajectory giving 80% chance of limiting the average global temperature increase to 2°C • Sets the target of cutting energy-related CO2 emissions by more than half in 2050 and ensuring that they continue to fall thereafter • The 2DS is broadly **consistent with the 450 Scenario through 2035**

3. RISK ASSESSMENT MODELS - OPERATOR-LEVEL VALUATION MODELS

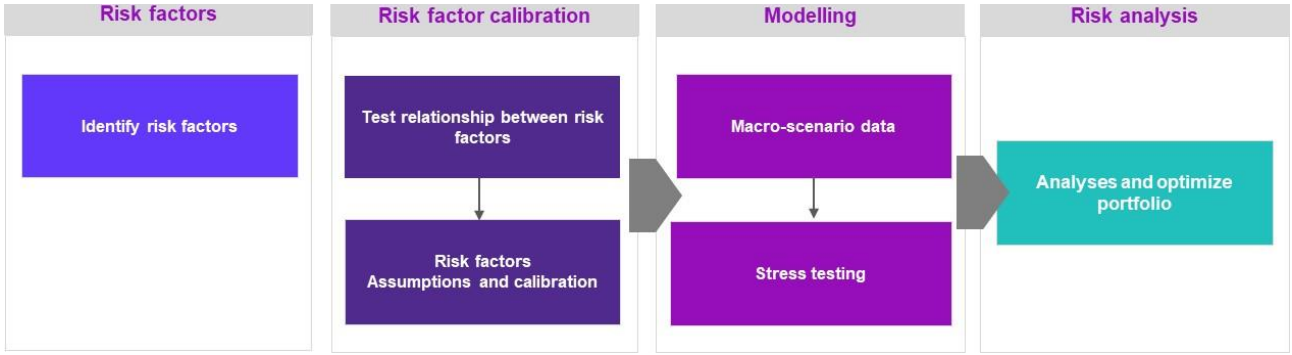
Valuation methods such as discounted cash flow (IRR/NPV/Break-even) are widely used at the physical asset, operator and financial asset levels. **Timing is a very important factor when assessing carbon risks** and scenario analysis using cash-flow or similar models **can incorporate a range of assumptions regarding when material events may occur in the future**. Scenario analysis can be used to evaluate the performance of a financial asset throughout the asset's lifecycle and across a range of assumptions, including both the probability of a policy or market shift and the financial impacts of the shift. At the industry level it can be used to take estimates of the whole industry's revenue and compare NPVs across different scenarios.

The outputs from the scenarios in simple terms **are cash flows and revenues**. Physical assets can be tested for the cash flow impact of changes in risk factors. The operators of these assets/companies can be tested for overall risk of assets in their various capital structures by applying DCF analysis to the portfolio of assets the company operates. Because new investments are, in effect, capital investments by the operator, they need to be put in the context of capital management overall, relative to shareholder returns, dividends/buybacks and diversification.

II. A TOP-DOWN APPROACH TO ASSESS CARBON ASSET RISK (PORTFOLIO LEVEL)

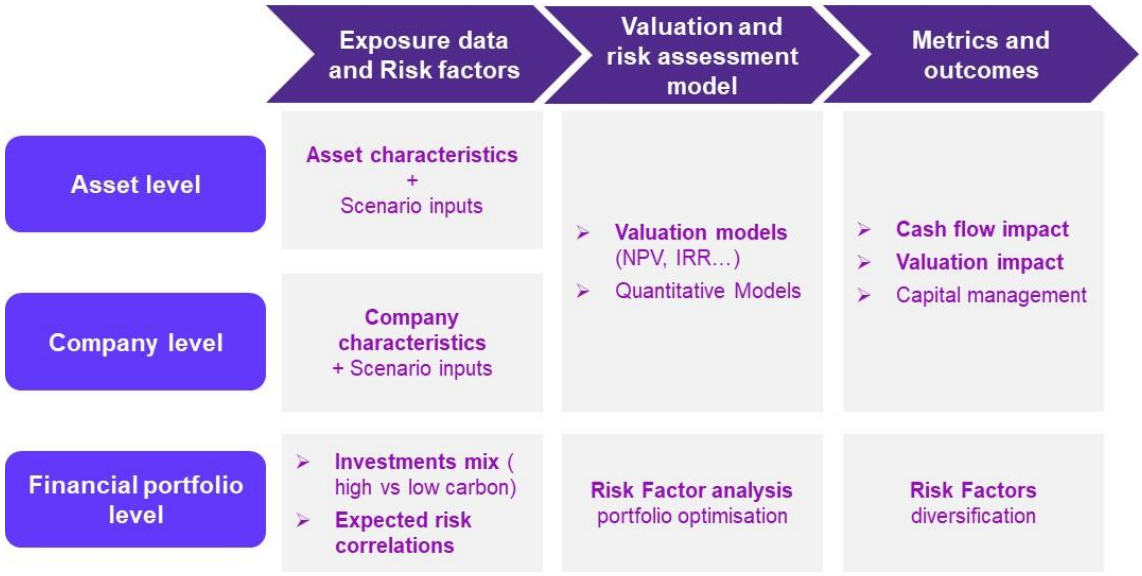
The portfolio-level approach is more oriented toward portfolio analysis. The core of the process—stress testing—is **similar to the bottom-up process described above**. However, there are critical differences, notably that the stress test is applied to the overall portfolio, **tracking interaction and correlation among investments (and thus diversification with low-carbon assets and other sectors**). Further, since the analysis operates at portfolio level, it is possible to optimise asset allocation based on which scenario an analyst believes to be most likely.

The process first identifies risk factors and then tests the relationships among them to ensure they are unique. These factors are then combined with macro-scenario data to stress test the portfolio and generate the data describing the impacts of changes in risk factors to the portfolio. In the final step the portfolio is analysed and potentially optimised with regard to the risk factors.



MAIN CONCLUSIONS

At the highest level, the financial impacts of carbon asset risk can be evaluated using a company-level framework aggregating physical assets up to portfolios or an assessment framework starting at portfolio level and analysing underlying investment types. In all cases, carbon risk exposure data and risk factors (that is, scenario inputs) serve as inputs to valuation and risk assessment models, creating outputs and metrics that summarise impact to investment value. Hereafter is described the high-level overview of the carbon asset risk assessment framework.



In conclusion, the framework proposed in this paper consists of a simple process to assess the sensitivity of asset portfolios to carbon risk at different levels of granularity. Although many challenges remain regarding data availability and granularity, it helpfully relies on classical practices and methods to assess carbon asset risk. It is a good first step for any institution that wants to strengthen its material risk identification process and potentially adapt its credit risk models.

HOW AVANTAGE REPLY CAN HELP?

Avantage Reply (a member of the Reply Group) is a pan-European specialized management consultancy delivering change initiatives in Risk, Finance, ALM, Treasury and Compliance within the Financial Services industry. Founded in 2004, Avantage Reply provides subject matter expert advisory for key ALM, Finance & Risk hot topics on CFO and CROs agendas. Our service offer **regarding climate risk management notably covers:**

Topic	Description
Business & Risk Strategy	• Advice and support to integrate climate-related issues into business planning and risk strategy (RAF) • Advice and support on embedding climate risk management into strategic processes (ICAAP…)
Governance	• Design and implementation of a climate risk management governance framework
Risk identification	• Integration of climate risk components into Material Risk Identification processes (climate risk driver identification and assessment, carbon asset risk assessment framework)
Risk management	• Portfolio analysis and sensitivity to transition and physical risk (incl. sector/geographic exposures) • Integration of climate risk components into Operational and Financial Risk Management frameworks • Design and implementation of "climate quality index" into existing credit risk models • Design and implementation of green/brown scorecard approach / green weighting factor
Stress testing / scenario analysis	• Design and implementation of a climate risk stress testing framework (interpreting and applying prescribed methodology, scenario generation linked to risks and business drivers, models/projections)
Supervisory compliance	• Gap analysis or action plan to design a climate risk management framework in line with supervisory expectations and market practices

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Nathanaël is a Partner of Avantage Reply France with more than fourteen years of experience in banking. He started his career as a derivatives trader and for the past ten years, has specialised in Risk, Finance and ALM strategic challenges.

He has notably assisted banks in developing and implementing RAF, ICAAP, ILAAP, RRP, Solvency and Liquidity stress testing frameworks but also ALM and risk management and measurement frameworks in line with industry best practices. Additionally, he has a strong knowledge of regulatory and supervisory expectations. Finally, he has worked for both European and French SFIs and LSIs.

Graduated from engineering school and two MSCs in quantitative finance, he also holds the FRM professional qualification (GARP) and the ALM professional qualification from the French ALM association (AFGAP).