Paris, May 2022

FINANCE

SCENARIO ANALYSIS OF TRANSITION RISK IN FINANCE

TOWARDS STRATEGIC INTEGRATION OF DEEP UNCERTAINTY

Authors: **Romain Hubert, Rachel Paya, Anuschka Hilke** and **Michel Cardona**

With the contribution of the European Union LIFE programme

ACKNOWLEDGEMENTS

This report is part of the Finance ClimAct project and was produced with the contribution of the European Union LIFE programme.

The authors of the report wish to thank the Finance ClimAct consortium and the people listed hereafter for their contribution at different stages of this work, including interviews on the methodologies and their use, broader exchanges on the framing of this work, and/or review of the draft report:

David Carlin (UNEP FI), **Chiara Colesanti Senni** (Council on Economic Policies, University of Zürich), **François Crénin** (Société Générale), **Anthonin David** (Deloitte),**Vivian Dépouès** (I4CE)**, Lisa Eichler** (Ortec Finance), **Andrew Grant** (Carbon Tracker), **Jean-Florent Helfre** (S&P Global Sustainable1), **Camille Laurens-Villain** (Caisse des Dépôts), **David Lunsford** (MSCI), **Antoine Mandel** (Climate Finance Alpha), **Jana Mintenig** (PwC), **Thomas Nielsen** (Planetrics a Vivid Economics company), **Tommi Oksanen** (Planetrics a Vivid Economics company), **Asli Oncel** (Deloitte), **Constantine Pretenteris** (Urgentem), **Alban Pyanet** (Oliver Wyman), **Bruno Rauis** (MSCI), **Nicole Röttmer** (PwC), **Christina Weimann** (S&P Global Sustainable1), **Isaac Woodman** (Urgentem).

DISCLAIMERS

TABLE OF CONTENTS

_ EXECUTIVE SUMMARY 4

_ INTRODUCTION 8

_ METHODOLOGY 10

I. The need to manage the deep uncertainty of the low-carbon transition based on scenario analysis 11

1. Uncertainties of the low-carbon transition make transition "risks" and opportunities more complex for financial actors 11
2. Information on the deep uncertainty of the low-carbon transition can improve financial actors' risk management strategies 13
3. Scenario analysis as a process for strategic integration of deep uncertainty: framework and added value 13

II. Good principles for a strategic integration of deep uncertainty using scenario analysis of transition risk 18

1. Building block 1: Framing the approach and governance 18
2. Building block 2: Exploring potential risk/opportunity drivers and impact propagation channels 20
3. Building block 3: Further steps of a materiality assessment 25
4. Building block 4: Selecting or building scenarios to assess potential impacts in a range of key plausible futures 28
5. Building block 5: Taking account of specific challenges and adaptive capacities when assessing transition impacts 31
6. Building block 6: Leveraging information on deep uncertainty to make decisions 35

III. Recommendations for effective implementation of good principles 38

1. Insights on service providers' progress: emerging best practices and points of attention 38
2. Building on existing dynamics of multiple stakeholders to move forward 42

_ CONCLUDING REMARKS 45

_ REFERENCES 46

EXECUTIVE SUMMARY

CONTEXT: FINANCIAL ACTORS NEED GUIDANCE TO TAKE FULL OWNERSHIP OF SCENARIO ANALYSIS OF TRANSITION RISK

In 2017, the TCFD introduced scenario analysis as a recommended approach to the strategic integration of transition risk for financial and non-financial companies. Since then, European regulators and supervisors have increasingly required financial actors to undertake scenario analysis of transition issues for risk management and strategic purposes and to disclose information on their approach.

However, financial actors are still disclosing a limited amount of information on their scenario analysis and how it contributes to their strategy. Their approach – often based on services developed by external providers – is not always fully transparent on key technical and organizational choices. This casts doubt on the motivations of financial actors to conduct scenario analysis, on the progress they have made and on their current capacity to target a relevant approach for strategic integration.

To help address these issues, this report provides guidance on how scenario analysis can bring added value to financial actors' risk management and business strategies and on how they can meet their disclosure requirements.

The report highlights how scenario analysis can bring added value to financial actors' strategy setting and implementation processes. It then provides recommendations on the optimal framework that financial actors should seek to implement at each step of the scenario analysis process. These recommendations are summarized in a practical checklist of guiding questions. The report also assesses the gap between available services and the optimal framework, and makes proposals on bridging this gap. In particular, the list of guiding questions can be used by financial actors and service providers to improve their approaches, and by financial regulators and supervisors to set expectations on good practices.

SCENARIO ANALYSIS OF TRANSITION RISKS IS NEEDED FOR STRATEGIC INTEGRATION OF DEEP UNCERTAINTY

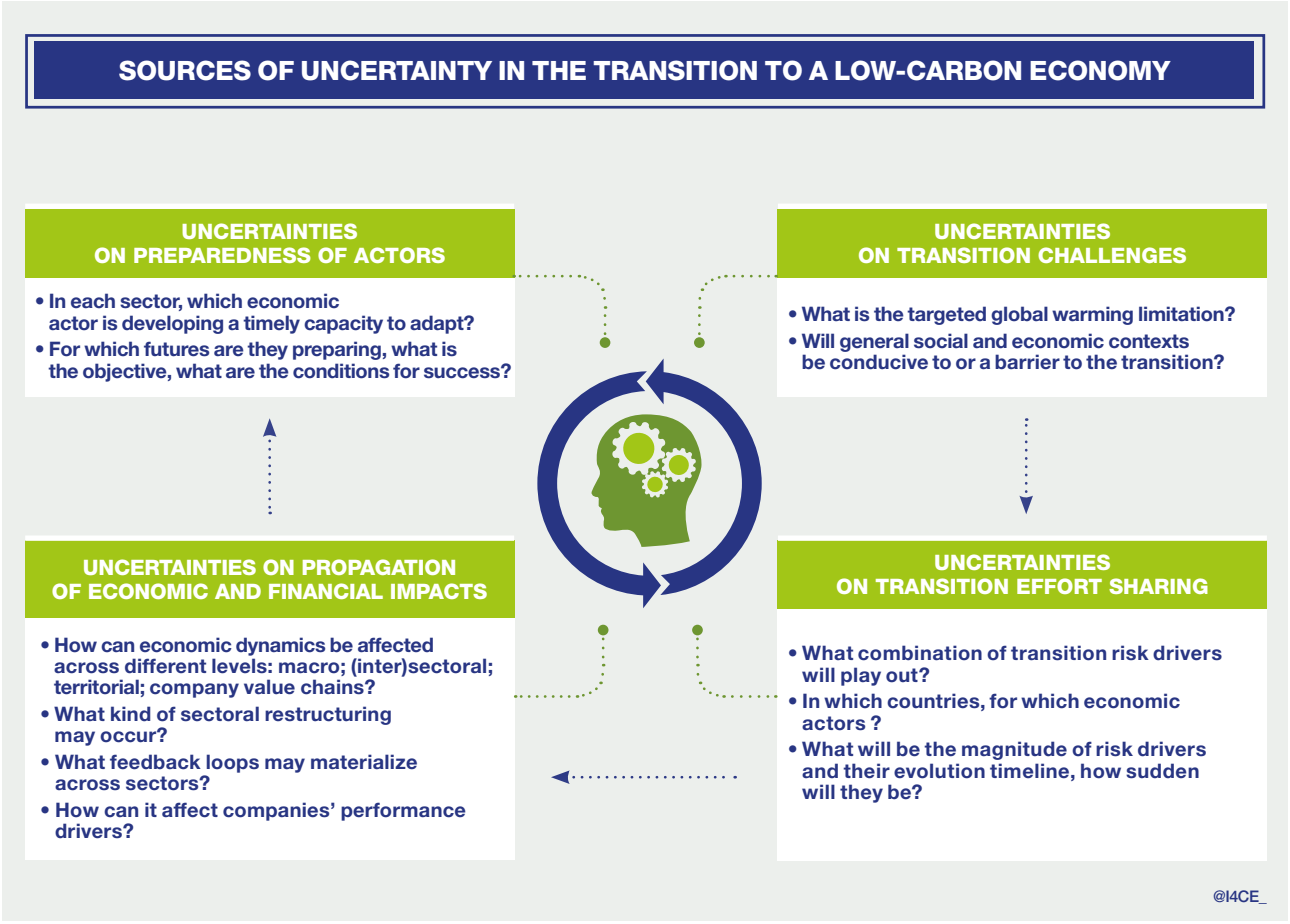
Better integration of deep uncertainty is key for financial actors' strategies and risk management

Conventional risk analysis and risk management approaches in finance are not inherently suited to taking account of the main characteristics of transition risk involving "deep uncertainty".

"Deep uncertainty" refers to difficulty anticipating the complex and unprecedented dynamics that may play out in the economy over the course of its transition to a low-carbon system, as outlined in the figure below. This deep uncertainty also includes difficulty identifying how these dynamics may impact financial institutions. Outcomes cannot be assigned with an objective probability distribution. This complicates the identification of information that may be useful to shape better decisions.

Efforts to explore deep uncertainty can bring added value to strategic thinking and planning. Such exploration cannot help to predict the future that will effectively materialize, or objectively rank the likelihood of plausible futures. However, it can help to better anticipate the potential plausible future dynamics of restructuring the real economy.

Through this process, financial actors could anticipate opportunities for new businesses in the real economy that will need financial services. They could also identify businesses that will need financial services to stop their harmful activities and to adapt their business model in line with the needs of goods and services in a net zero economy. This may also help financial actors to target key indicators to be monitored in the economy and portfolios and to make timely decisions that avoid strategic dead-ends. In particular, it may enable financial actors to appreciate the spectrum of potential futures where strategic financial resilience can be reached and to integrate this consideration into their processes.



Scenario analysis ensures strategic integration of deep uncertainty

Scenario analysis is a pragmatic process that is suited to supporting an institution's decision-making in a context of deep uncertainty. It structures a relatively broad exploration of potential futures while restricting the field of exploration to focus on what could impact the institution.

In addition, scenario analysis is much more than a purely technical approach providing an output metric. It is part of a mainstreaming process of transition risk and deep uncertainty in an institution's strategic thinking, planning and implementation processes. With this perspective in mind, scenario analysis may involve the institution's teams in the whole process. This can be beneficial for the institution on several levels: improving capacity to understand transition issues; building synergies with existing risk management processes; defining a rationale for decision-making under deep uncertainty that suits the institution and providing relevant metrics accordingly.

PRINCIPLES FOR AN OPTIMAL SCENARIO ANALYSIS FRAMEWORK

Ideally, a range of principles should be implemented in the scenario analysis process to ensure relevant exploration of deep uncertainty and proper integration into decisions. These principles should include not only technical requirements, but also organizational requirements seeking to identify the financial institution's specificities and to involve its teams. This report proposes a detailed and non-exhaustive list of such ideal principles. They are categorized according to six building blocks that focus on major aspects of a scenario analysis process. These building blocks are not necessarily representative of the effective steps of the process and their chronological order.

1. FRAMING AND GOVERNANCE

Involve all relevant teams to ensure the process leads to strategic integration of deep uncertainty

- Identify internal coordinators for the scenario analysis process and build their capacity
- Identify key teams to involve (Managers, ESG, Risks, etc.) and diagnose internal capacities and needs
- Tailor a scenario analysis plan that involves key teams to address their needs and use their capacities with the objective of fostering strategic integration of deep uncertainty

2. EXPLORING OPPORTUNITY AND RISK DRIVERS AND IMPACT PROPAGATION CHANNELS

Build understanding of complex propagation channels of transition impacts in the real economy

- Explore propagation of impacts through the real economy, without forgetting direct impacts on financial actors
- Explore transition dynamics and implications from long to short term with a forward-looking mindset
- Identify uncertain evolutions as well as heavy trends
- Consider a range of risk drivers (policy, technology, behaviors) and financial vulnerabilities in economic sectors
- Include all levels of propagation (sectoral; cascading effects across sectors; macro; feedback effects over time)

3. IDENTIFYING MATERIAL RISKS

Focus efforts on essential areas for further assessing the financial consequences of deep uncertainty

- Explain how the key dimensions of materiality are considered (risk drivers; exposure; vulnerability; time horizon)
- Use a sectoral approach to appreciate exposure and vulnerability
- Consider combinations of risk drivers that are relevant for the sectors under analysis
- Consider several transition dynamics from long to short term, including disorderly transitions

4. SELECTING OR BUILDING SCENARIOS

Handle overwhelming range of potential transition futures by identifying a subset of relevant transition scenarios for assessing impacts on the targeted system

- Understand what drives the multiplicity of transition dynamics and the resulting scenarios
- Include disorderly transition scenarios to highlight challenges from short to long term
- Use scenarios representing targeted financial impacts with sectoral and country granularity & relevant time step
- Update scenarios regularly with recent observations and emerging trends
- Limit subjective choices by building on scenarios developed with public authorities for financial risk assessment

5. ASSESSING IMPACTS WHILE ACCOUNTING FOR SPECIFIC ADAPTIVE CAPACITIES

Integrate complex dynamics at asset-specific level to appreciate specific risks and opportunities and assess net financial impacts

- Analyze transition challenges at level of counterparty: its country and activity exposures; transition stage; anticipated lock-ins; business and competitive environment; issues from a range of key scenarios
- Integrate the counterparty's capacity to address its challenges: potential solutions; resources; resilience strategy (consistency with overall strategy; feasibility; targeted domain of resilience; operationalization)

Potentially include financial actors' own adaptive capacity, **discussing their transition risk strategy in context of overall business strategy (including Paris alignment strategy)**

6. PROVIDING DECISION-USEFUL INFORMATION ON FINANCIAL IMPACTS

Develop decision criteria and metrics that demonstrate the added value of information on deep uncertainty when making decisions

- Explore smart decision rationales under deep uncertainty
- Choose a decision rationale and subsequent metrics
- Involve teams in choices above, communicate and monitor how they implement these choices
- Build trust in the approach: keep it state-of-the-art and explain how its boundaries affect the reliability of results

@I4CE_

RECOMMENDATIONS FOR PROGRESS TOWARDS IMPLEMENTATION OF THE OPTIMAL SCENARIO ANALYSIS FRAMEWORK

The need for support to generalize emerging best practices

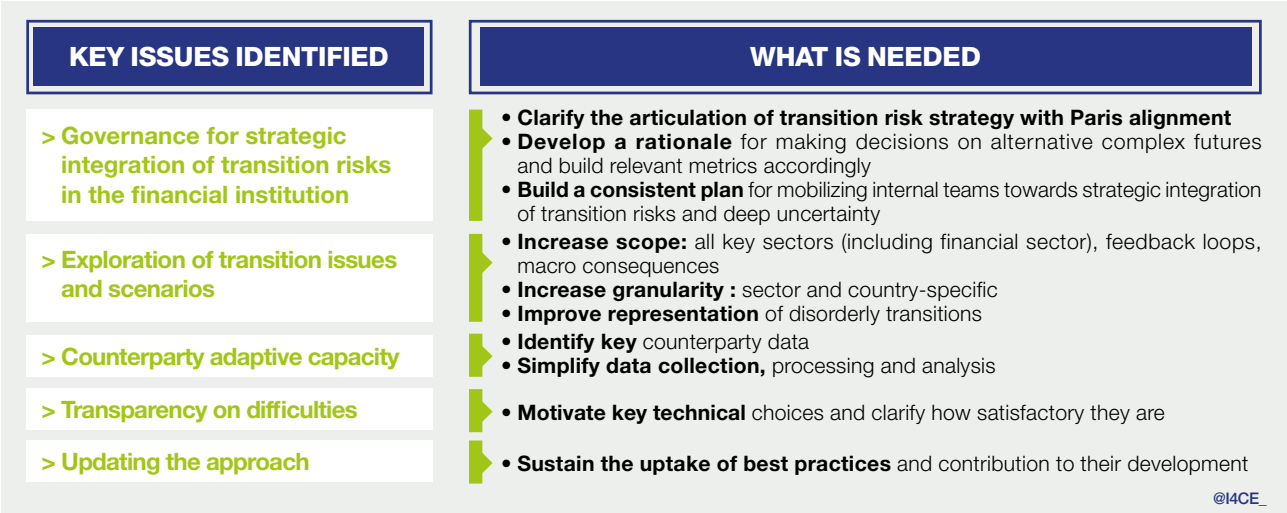
I4CE has carried out an in-depth review of selected services that focus on scenario analysis of transition issues for financial institutions' internal processes and disclosure obligations.

The landscape of approaches developed by service providers already demonstrates a patchwork of valuable expertise. Some relevant practices are observed on key technical aspects. This includes for instance the capacity to customize materiality assessment, or the use of a range of state-of-the-art and publicly available scenarios covering 1.5°C and 2°C transition pathways. In addition, some service providers also make interaction with their clients/users a core aspect of their scenario analysis process.

However, best practices are not equally implemented in the broader landscape of approaches, and demand is still limited for some of them. There is thus a need to encourage their generalization.

The need to better mobilize teams and to continue to address technical challenges

The review of services shows that a range of difficulties should be addressed to foster strategic integration of deep uncertainty through scenario



analysis in financial institutions. Key issues were identified on the main building blocks and transversal aspects of scenario analysis, as summarized in the figure below. This covers not only technical challenges, but also challenges for the coordinated mobilization of financial institutions' teams to integrate transition risk and deep uncertainty into risk management and strategic processes.

Regulators and supervisors should help to address these needs by guiding scenario analysis implementation

The development and generalization of relevant practices can be sustained by integrating minimum technical requirements into regulatory disclosure frameworks (as is the case in France through Art. 29 LEC) and supervisory reviews of financial institutions' internal processes.

Emphasis should be placed on encouraging financial institutions to mobilize their teams on scenario analysis with a strategic perspective. Appropriate governance should be emphasized in supervisory reviews of internal processes. Disclosure requirements should also target the governance of the scenario analysis process. Progress is being made in France under the Art. 29 LEC implementing decree and expected at the European level under the CSRD, and should be reinforced in other contexts. Effective disclosure on governance should also be closely monitored.

Regulators and supervisors could also clarify how institutions should articulate their transition risk strategy with their Paris alignment strategy and overall business strategy. As part of the prudential perspective, alignment of the financial sector is needed to avoid higher long-term risks for the whole economy arising from a delayed and disorderly transition. However, financial actors seem to have focused on short-term risks and the idea that not contributing to the transition has not yet exposed them to any significant risk. Regulators and supervisors should establish requirements to address short-term risks for institutions and long-term economy-wide risks in a balanced way, while recognizing differences in the risk profiles of institutions. This could help financial actors to build an appropriate transition risk strategy that is consistent with Paris alignment considerations.

A broader range of stakeholders should collaborate to address these needs

Encouraging co-design approaches can also be a good way to involve the relevant teams in financial institutions (e.g. through supervisory climate stress-testing or through research initiatives).

Concerted work can also be organized to build sectoral transition plans at the national level. This could help to explore potential sectoral dynamics and create a shared view of potential transition pathways at the national level. Ongoing research could also enrich scenario modeling on various aspects and should be made visible, for example by the NGFS.

Various stakeholders can also help with counterparty-level data. Financial actors can engage with counterparties where possible. Harmonized reporting and automated collection could also facilitate data use, as envisioned by the European Single Access Point. Big data approaches may also help. Rating agencies could also take charge of the analysis at counterparty level, provided their approaches become sufficiently transparent and appropriate for decision-making by financial institutions with diverse needs.

INTRODUCTION

CONTEXT

The financial sector is exposed to risks and opportunities in the uncertain transition process towards a low-carbon economy

The financial sector is exposed to financial impacts arising in the context of the transition to a low-carbon economy. Some activities in the real economy will need to significantly shrink or disappear, while others will gain momentum, exposing financial actors to potential losers and winners of the transition.

The analysis and management of these transition risks and opportunities is complicated by the "deep uncertainty of the low-carbon transition". This refers to difficulty anticipating the complex and unprecedented dynamics that may play out in the economy over the course of its transition to a low-carbon system and how these may impact financial institutions. A salient characteristic of deep uncertainty is that the objective probability distribution of outcomes cannot be estimated.

Scenario analysis is recommended for financial actors to take account of transition uncertainties in risk management and their overall strategy

Disclosure frameworks have provided recommendations to take better account of this deep uncertainty in risk management. In 2017, the TCFD ("Strategy c" disclosure item) recommended analyzing and managing transition risks and opportunities based on "scenario analysis". Scenario analysis of transition risks and opportunities is now becoming mainstream in regulatory disclosure frameworks. This has been the case in France since 2021, through the decree implementing article 29 of the French Energy and Climate Law, and in Europe through the ongoing processes under the CSRD.

In the context of the NGFS, supervisors have also been developing a range of transition scenarios to be used by financial actors and supervisors in pilot climate-related stress-testing exercises, pointing out the need for risk management processes to explore this deep uncertainty. Financial actors are now urged by regulators and supervisors to effectively manage their exposure to climate-related risks with inputs from scenario analysis (EBA 2021; ECB, 2020; ECB, 2021; BCBS, 2021).[1]

The need for guidance on how scenario analysis methodologies should address transition uncertainties in the context of risk analysis

In parallel to increasing expectations from disclosure frameworks, a range of methodologies based on scenarios have emerged to help financial actors to analyze their exposure to transition risks and opportunities as well as to analyze financial portfolio alignment with a low-carbon trajectory. The methodologies were developed based mainly on the efforts of several service providers. A lot of financial institutions have been using such tools as a basis for their climate-related disclosures or in the context of supervisory climate-related stress-testing exercises.

However, the quality of information disclosed by financial actors about their scenario analysis has so far disappointed observers, financial regulators and supervisors alike. As part of the explanation for this limited disclosure, it has been reported that the analytical tools lack transparency about their key assumptions and overall rationale (Climate Transparency Hub, 2021; TCFD, 2021; ECB, 2022).

This has raised doubts about the extent to which current scenario-based risk analyses actually make a convincing exploration of the deep uncertainty of the low-carbon transition. It has also raised doubts about how they use this exploration to enhance information on transition risks and opportunities, for the purposes of disclosure and/or internal decision-making processes.

1. Recently, this has overlapped with a context in which financial actors are also urged to connect the dots with the need to build transition plans (EFRAG, 2022). In other words, this highlights the need to connect the risk narrative with the economic system-change approach necessary for restructuring the economy towards net zero global emissions by 2050 at the latest in order to have a chance of limiting global warming to below 1.5°C. While this topic is critical, it is not the focus of the present report.

While the landscape of methodologies is evolving rapidly, sustained efforts are needed to ensure steady transparency on the analytical approaches over time.

In parallel, guidance is needed to clarify on which aspects and where the methodologies should seek to converge so as to provide a convincing exploration of uncertainties that is also reflected in the results. Financial actors' decision frameworks are not inherently equipped for integrating deep uncertainty. They do not necessarily have the keys to efficiently identify the potential transition futures that may have an impact on them. Concerns also arise from their decision rationales, for instance because they may rely on probability distributions for making optimal choices. Although financial actors and supervisors are gradually gaining experience of scenario analysis for transition risk management, this exercise remains quite new in the financial sector. Further guidance on scenario analysis can thus help financial actors to efficiently structure the exploration of these transition futures and their potential consequences. Further guidance can also help them to target specific element of the expected added value of this exploration and to shape decision rationales that make full use of this information.

OBJECTIVES OF THIS REPORT AND CONTENT

The present report provides some elements of guidance towards good practices for scenario analysis of transition risks and opportunities in financial institutions. The focus of this guidance is the exploration of the deep uncertainty of the low-carbon transition in scenario analysis and its integration into a financial institution's transition risk management and its overall business strategy.

The report identifies some ideal good principles, which are categorized according to six key building blocks of a scenario analysis of transition risks and opportunities. If applied, these essential principles would theoretically improve the exploration of uncertainties and its added value for decision-making. A set of "guiding questions" summarizes the good principles for each of the key building blocks.

This guidance may help financial actors to clarify the state of existing approaches and to improve their in-house developments or their collaboration with service providers. This may help them to add value to their internal decision-making processes, but also to fulfill their disclosure requirements, and could help with supervisory exercises. This guidance may also provide relevant insights to a broader set of stakeholders (e.g. service providers, supervisors, scenario developers) and lead to discussions about the conditions for ensuring the feasibility of these recommended principles and ways to remove the barriers in priority areas of improvement.

As scenario analysis is a flexible, evolving process, the "key building blocks" identified in this report should not be read as a standard step-by-step protocol for scenario analysis, but rather as a number of proposed elements to be integrated at some point in the process. Furthermore, this report does not claim to provide an exhaustive, definite identification of all the necessary building blocks for a convincing scenario analysis of transition risks and opportunities. More discussion is needed to identify what input is necessary for a range of financial institutions to make decisions under deep uncertainty, and from which perspective.

The **methodology section** below explains the process underpinning the elaboration of the guidance and other conclusions presented in this report. **Section I** explains why deep uncertainty is a central issue in analyzing and managing transition risks and opportunities and how scenario analysis can help. **Section II** sets out some building blocks of a theoretically optimal scenario analysis of transition risk and introduces good principles summarized as guiding questions on the main aspects of each key building block. The **concluding section** highlights emerging best practices and some of the main challenges identified for existing scenario analysis. It also proposes some areas of work to address these challenges.

METHODOLOGY

DRAFTING THE GOOD PRINCIPLES PRESENTED IN SECTION II

To draft a list of ideal good principles for scenario analysis of uncertain transition risks and opportunities, I4CE carried out research combining various points of view and fields of expertise.

The good principles build partly on I4CE's stocktaking exercise of the approaches developed by service providers on scenario analysis of transition risks and opportunities for financial institutions. The stocktaking methodology is described in the box below.

In particular, the good principles take inspiration from the theoretical framework targeted by the services under review. The principles do not necessarily reflect how the services effectively implement the theoretical frameworks.

BOX 1 – I4CE'S PROCESS TO REVIEW APPROACHES TO SCENARIO ANALYSIS OF TRANSITION RISK FOR FINANCIAL INSTITUTIONS

In 2020, based on an extensive literature review and expertise, I4CE identified 65 methodologies that take account of climate issues, developed by service providers.

Moving forward, I4CE short-listed a dozen of methodologies focusing on scenario analysis of financial transition risk developed by different service providers. The selection was based on publicly available information about the methodologies, which was used to set objective expectations on their relevance. The selection also reflects the objective of having a sample of methodologies representative of the diversity of available approaches.

In-depth and systematic desk review was carried out on each of the sampled methodologies, highlighting potentials and current limitations. I4CE contacted the selected service providers and users for in-depth interviews to clarify intentions, needs and limitations related to scenario analysis. Interviews were carried out with respect to the following methodologies: 2 degrees of separation (Carbon Tracker); Carbon Earnings at risk (S&P Global Trucost); Climate Excellence (PwC); Climate MAPS (Ortec Finance); Climate Risk Toolkit (Vivid Economics); Climate Value at Risk (MSCI); ClimWise (Deloitte); Element 6 Climate Risk Platform (Urgentem); Transition Check (Oliver Wyman – UNEP FI TCFD Banking Program); CLIMAFIN (Climate Finance Alpha).

This review was completed by a literature review of previous stocktaking exercises carried out by other institutions on overlapping topics, including IIGCC (2019), Bingler and Colesanti Senni (2020), NGFS (2020a), and UNEP FI (2021).

The good principles also take account of insights from other fields of research, development and experiences that may shed light on other aspects of scenario analysis potential. In particular, the good principles apply logic inspired to some extent by strategic foresight approaches developed by and/or for non-financial companies on different topics. This includes scenario analysis approaches for strategic integration of transition risks and opportunities, as summarized by I4CE in the context of the Re-Imagining Disclosure project (I4CE, 2020). The good principles also take inspiration from the research and practices on decision-making under "deep" or "radical" uncertainty, as discussed by I4CE in a previous research paper (I4CE, 2019a). To some extent, they also rely on experience gained in the ClimINVEST research project that explored similar topics on physical climate risk (ClimINVEST, 2021).

PREPARING CONCLUSIONS ON EMERGING BEST PRACTICES, TRENDS IN TERMS OF CHALLENGES AND POTENTIAL PRIORITY ACTIONS

The conclusions on the emerging best practices and broad main challenges build mainly on the abovementioned stocktaking exercise, including an in-depth review of selected approaches completed with service providers and sent to them for appraisal, broader discussions and a review of existing stocktaking reports.

The proposals for priority action on areas of improvement arise from the whole process and sources mentioned above, as well as a review of the current approaches of regulators and supervisors.

I. THE NEED TO MANAGE THE DEEP UNCERTAINTY OF THE LOW-CARBON TRANSITION BASED ON SCENARIO ANALYSIS

The analysis of transition risks and opportunities is complicated by "deep uncertainty". It is important to acknowledge that such uncertainty is very broad – and to some extent cannot be resolved – and to find ways to take it fully into account in transition risk management. This can be done through dedicated approaches such as scenario analysis.

1. Uncertainties of the low-carbon transition make transition "risks" and opportunities more complex for financial actors

1.1 THE TRANSITION TO A LOW-CARBON ECONOMY CREATES RISKS AND OPPORTUNITIES FOR ALL SECTORS

The transition to a low-carbon economy requires an unprecedented restructuring of many economic activities worldwide. In order to limit global warming to below 1.5°C, this restructuring will need to lead the global economy to net zero greenhouse gas emissions by 2050. In this transition process, some activities will need to disappear or be significantly reduced, while others will need to transform through a "decarbonization" process, and yet others may emerge to support low-carbon lifestyles.

Financial institutions can be exposed to the potential winners and losers of the transition through their decisions to provide a selection of economic agents with funds and financial services. The transition therefore represents potential business opportunities as well as financial risks of loss for financial institutions.

Potentially all economic sectors and countries are concerned by transition risks and opportunities to a variable extent[2]. All economic activities rely more or less heavily on GHG emissions directly through their operations. They may also rely on GHGs through their suppliers and markets. This dependency on GHGs can reach the far ends of value chains through intersectoral connections (up to primary suppliers and down to end consumers). Activities that support a low-carbon transition or businesses that plan their transition to make themselves compatible with a low-carbon transition might also be successful only in a limited number of possible evolutions.

1.2 "DEEP UNCERTAINTY" MAKES TRANSITION RISKS AND OPPORTUNITIES MORE COMPLEX FOR FINANCIAL INSTITUTIONS

A. Defining the "deep uncertainty" of the low-carbon transition

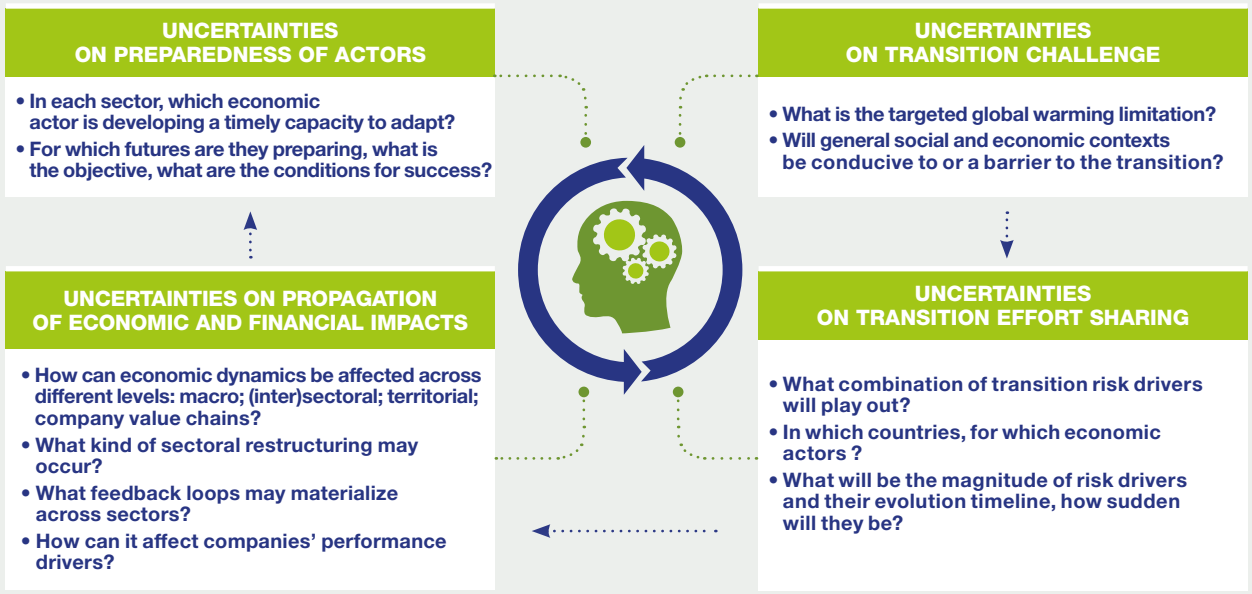
In practice, it is complicated for financial institutions to measure their exposure to the financial impacts of transition risks and opportunities. This is due to broad uncertainties about how the transition process will effectively materialize and translate into financial impacts on financial institutions.

For example, as illustrated in Figure 1, there is uncertainty about whether the general socioeconomic context will be conducive to a low-carbon transition and what will be the driving forces of the transition. In addition, it is not possible to predict the temporality and ambition of the GHG emissions reduction process, or how the effort may be split across countries and economic activities. There is also uncertainty about whether companies will be prepared to absorb this unpredictable process internally by stopping their incompatible activities and building new activities that are not only transition-compatible, but also competitive. The reactions of the financial sector – with a potential shift in market sentiment – are also unpredictable.

These sources of uncertainty result in a situation of "deep uncertainty". This expression is used here to reflect the complexity of analyzing potential future transitions and of making decisions based on this information. In more detail, according to the DMDU Society:

2. While some activities and projects – such as plans for additional major coal extraction capacities – are essentially at risk in any ambitious low-carbon trajectory (IEA, 2021; Carbon Tracker, 2021), the challenge for other activities will depend more on the shape of the transition and the specific characteristics of businesses. In any case, the preparedness of economic actors for one or several transition scenarios will be a key determinant of their resilience to the risk and their capacity to grasp the opportunities of the low-carbon transition.

FIGURE 1: VARIOUS SOURCES OF SOCIO-ECONOMIC UNCERTAINTY IN THE TRANSITION TO A LOW-CARBON ECONOMY FOR FINANCIAL ACTORS



Source: I4CE, 2022, Scenario analysis of transition risks in finance

@I4CE_

"Deep uncertainty exists when parties to a decision do not know, or cannot agree on, the system model that relates action to consequences, the probability distributions to place over the inputs to these models, which consequences to consider and their relative importance. Deep uncertainty often involves decisions that are made over time in dynamic interaction with the system."[3]

A key characteristic of deep uncertainty is that some of it may not be eliminated before decisions need to be made. While access to better data and modeling may reduce some aspects of uncertainty, it may not resolve them all. Typically, the potential future transition scenarios and their outcomes cannot be assigned with an objective probability distribution. The unprecedented restructuring of the economy towards a low-carbon system may lead to disruptions in normal economic patterns and, as a result, economic parameters may evolve beyond their usual expected range of uncertainty.

B. Deep uncertainty is a challenge for financial actors

The deep uncertainty of the low-carbon transition represents a challenge for financial actors' usual risk decision frameworks[4]. They do not necessarily have the keys to efficiently identify the potential transition futures that may have an impact on them. They may also need to expand the horizon of potential changes they consider, to better identify implications even for the short term. Concerns also arise from financial actors' decision rationales, for instance because they rely on backward-looking information and on models that tend to replicate dynamics from the past, while the low-carbon transition is a permanent restructuring of the economic system. They also often rely on probability distributions used in a rationale of optimal choice.[5]

In spite of this complexity, financial actors can benefit considerably from properly exploring and managing the uncertainties of the low-carbon transition.

3. To access this definition online and for more information on the concept of "deep uncertainty", see the DMDU Society's website (https://www.deepuncertainty.org/). More information is also available in Marchau et al. (2019).
4. Since Knight (1921), the term "risk" has been used formally to describe situations where all parameters are clearly identified, and all potential futures can be assigned with an objective likelihood of materialization. However, "transition risk" refers more loosely to potential losses arising from the transition to a low-carbon economy. Formally speaking, it is not a perfectly defined and objective probabilistic "risk" in the sense of Frank Knight, but more essentially "deep uncertainty". In this report, we use the loose terminology of "transition risks" and opportunities as well as the "transition uncertainty" terminology interchangeably.
5. For further explanation of the challenges for financial actors' risk management processes, see section II.6 of this report, or for instance section II.2 of I4CE (2019a).

2. Information on the deep uncertainty of the low-carbon transition can improve financial actors' risk management strategies

2.1 BETTER INFORMATION ON DEEP UNCERTAINTY DOES NOT MEAN PREDICTING THE FUTURE OR NECESSARILY ASSIGNING PROBABILITIES

Information on the deep uncertainty of the low-carbon transition arises from a better exploration of potential plausible futures. This does not mean predicting the future. The exact shape of the transition cannot be predicted in advance. While a range of potential futures can still be identified, they cannot be assigned with an objective probability of materialization, as mentioned in the definition of deep uncertainty. For example, a sudden shift in market sentiment on the transition cannot be assigned objectively with a probability of materialization. Some dynamics and mechanisms of the future transition might even remain unidentified until they materialize.

2.2 BETTER INFORMATION ON DEEP UNCERTAINTY CAN HELP FINANCIAL ACTORS TO BUILD EFFECTIVE STRATEGIES

However, a better exploration of the potential plausible futures can help financial actors to improve their financial risk strategies and their implementation in several ways, as explained below.

The objective of scenario analysis is not to reassure financial actors that there is no strategic issue with transition risks and opportunities. The exploration of potential futures may provide relevant insights not only on the risks of loss, but also on the opportunities of the transition to a low-carbon economy. This enables financial actors who explore these potential futures to shed light on opportunities for creating value and developing businesses strategically, while taking account of the risks of loss.

Furthermore, the exploration of potential transition pathways from now to the long-term may also help financial actors to identify key indicators that need to be monitored in order to effectively manage the risks and opportunities. This may also help to anticipate actions that need to be taken now to fulfil the strategy and to avoid dead-ends. Doing so may also help them to better understand the level of risk of loss and the opportunities to which they are exposed through different assets, taking account not of one future, but of a broader range of potential futures with key implications. It can therefore provide an indication of the financial resilience of their assets in a spectrum of key potential transition futures. Information on this spectrum of resilience could inform the financial actors' strategies for managing risks and opportunities *(as illustrated in section II.6).*

3. Scenario analysis as a process for strategic integration of deep uncertainty: framework and added value

Exploring the unprecedented transition to a low-carbon economy and its financial implications can be daunting, as can the process of identifying how the resulting information can be integrated into a strategic framework. Scenario analysis is a dedicated approach to achieve this.

3.1 MAIN PRINCIPLES OF SCENARIO ANALYSIS AND TARGETED ADDED VALUE FOR AN INSTITUTION'S STRATEGY

A. Efficiently structuring the exploration of uncertain future dynamics

Scenario analysis seeks to provide an efficient and relatively broad exploration of potential transition futures and their financial consequences, pushing the boundaries of our current understanding. To do so, it structures and delimits this exploration effort by defining and targeting decision-relevant information.

As opposed to other techniques such as sensitivity analysis, scenario analysis focuses on the joint future dynamics that a targeted asset or portfolio may potentially face in a context of low-carbon transition, leading to potential risks and opportunities. It then builds a limited set of alternative transition scenarios around uncertain evolutions that may arise in the transition and that are key for the targeted asset or decision.

Scenario analysis seeks to consider a range of contrasted alternative scenarios on several themes (e.g. a scenario with high fiscal pressure and low change in consumer preferences; another scenario with high change in consumer preferences and lower fiscal pressure), rather than one central scenario with variations around a single question (e.g. a carbon pricing policy and sensitivity analysis based on variations in this carbon price within a given range).

Moreover, scenario analysis does not necessarily seek to build a subjective probability distribution of potential futures and their outcomes. It enables financial actors to explore other ways to make decisions based on scenarios.

B. Mobilizing teams of financial institutions in an effective strategic integration process

The objective of scenario analysis is to explore the potential financial losses and opportunities arising in each scenario so that, depending on the results, financial actors can revise their risk decision-making[6].

To facilitate this strategic integration, the scenario analysis process may involve the engagement of the financial institution's decision-makers in thinking about how their decision rationale should be reshaped to take account of deep uncertainty. The result of this reflection should inform the choice of the relevant metrics to be provided to inform the decision.

More broadly, the scenario analysis may mobilize the relevant teams in the financial institution in the whole of the exploration process. In doing so, it builds the capacity of the teams to fully understand the transition dynamics in the real economy and how these can lead to risks or opportunities. This may help the teams to identify indicators to be monitored and other actionable management solutions at the scale of the financial institution (e.g. guidance for engaging dialogue with counterparties on their financial resilience to the transition).

In addition, scenario analysis can be approached as a flexible and iterative process. This enables financial institutions to develop a methodology according to their resources, objectives and needs, and to expand the scope and complexity of the analysis over time.

In the ideal case, the proper exploration and integration of deep uncertainty needs to be carried out through a number of key building blocks of the scenario analysis process, as detailed below.

3.2 TECHNICAL AND ORGANIZATIONAL REQUIREMENTS FOR A STRATEGIC INTEGRATION OF DEEP UNCERTAINTY THROUGH SCENARIO ANALYSIS

As shown in Figure 2, different building blocks of scenario analysis should help to explore deep uncertainty and to reflect it in decision-relevant information on risks and opportunities for financial actors. The building blocks presented in Figure 2 are not necessarily representative of the phases of every scenario analysis. Nor are they representative of the exact chronological order of the scenario analysis steps, which could also be iterative in practice. Instead, the building blocks should be considered as some of the key aspects of scenario analysis that are generally common to the vast array of approaches.

Below is a brief introduction on how the main building blocks of the scenario analysis process can help to integrate the main aspects of deep uncertainty that were introduced in section I.1.

A. Building block #1: Framing and governance

Through this building block, this report emphasizes the need to organize the mobilization of internal teams at an early stage, with the objective of using the scenario analysis process to ultimately foster the strategic integration of deep uncertainty. Integrating internal teams into the process enables them to take up the process and results and to contribute to the analysis. *(Details in section I.1.)*

B. Building block #2: Exploring opportunity and risk drivers as well as impact propagation channels

This building block focuses on the specific work required to push the boundaries of knowledge on potentially relevant dynamics of the transition and the channels for transmission of its impact to the financial institution. The report explains some good principles to ensure a satisfactory exploration effort, with the objective of identifying key issues of the transition for the assets under study. *(Details in section I.2.)*

C. Building block #3: Identifying material risks

It may not be essential that further assessment focuses on the complete set of potential impacts identified in the previous building block. A subset may be enough, depending on the characteristics of the institution's portfolios and the potential evolution of risk drivers. Finding a way to prioritize the key aspects can be an efficient practice per se to navigate the complexity of potential transition futures and impacts that characterizes deep uncertainty.

The criteria used to prioritize elements of the scope of analysis can also affect the relevance of the final scope. This report thus identifies several good principles that should limit the risk of losing relevance with the scope of analysis ultimately selected. *(Details in section II.3.)*

6. In parallel to scenario analysis for financial risk and opportunity management, some financial actors select one transition scenario to assess how their portfolio is compatible with such a scenario. This other type of scenario analysis is called a "portfolio alignment assessment". Some financial actors use it as an input for their institutional strategy to align with the transition to a low-carbon economy. The methodologies for scenario analysis of "portfolio alignment" are not covered in the present report, but are detailed in ILB and I4CE (2020).

D. Building block #4: Selecting or building scenarios

This building block addresses a major aspect of deep uncertainty, that is the infinite range of potential transition futures and the impossibility of objectively identifying the most credible one. It may be impossible to identify all of these futures and to test for their impacts on the targeted assets. To deal with this range of potential futures, based on the previous building blocks, a subset of scenarios is selected to highlight key risks and opportunities for the targeted assets. The scenarios usually also include an assessment of macro and sectoral economic impacts.

The report identifies good principles to select (or build) a relevant range of scenarios based on objective criteria, while addressing the remaining subjectivity in the selection process. *(Details in section II.4.)*

E. Building block #5: Taking account of specific adaptive capacities when assessing impacts

The mapping of key propagation channels and dynamics (discussed in Building block #2) is combined with the selection of scenarios (Building block #4) to assess impacts on the selected scope (Building block #3), with additional modeling to assess impacts on the targeted assets.

A key aspect of deep uncertainty to be explored here concerns the specific dynamics occurring at counterparty-level that shape the capacity to adapt to transition impacts. The adaptive capacity of the financial institution can also be integrated into the analysis.

The report identifies good principles to explore the specific transition issues of any type of counterparty as well as their capacity to adapt to these issues, including a focus on the counterparty's strategic resilience. It also provides good principles to build the financial institution's strategic integration of transition risks and opportunities. *(Detailed in section II.5.)*

F. Building block #6: Providing decision-useful information on financial impacts

This final building block provides good principles for financial actors to shape their strategy in a way that takes advantage of the information on deep uncertainty generated by the scenario analysis.

The principles include an exploration of decision criteria that could benefit from this information on deep uncertainty, the choice of a decision rationale and the subsequent design of appropriate metrics to inform decisions. They also include a discussion on how to determine whether the information on deep uncertainty can be trusted for the results. *(Detailed in section II.6.)*

G. The building blocks vs. the practical steps of a scenario analysis

The six building blocks are presented in this specific order so as to be generally consistent with the practical steps of a scenario analysis process. However, they are not necessarily representative of the concrete steps of a scenario analysis process, or their chronological order.

The building blocks focus on specific aspects of scenario analysis where recommendations on good principles could be identified. They do not seek to reflect the exhaustive set of issues that should be discussed in practice to build a consistent and efficient process. For example, in practice, the "framing and governance" step may also include the definition of a strategic objective by the top management, which may shape the questions asked and the technical choices made.

In addition, in practice, scenario analysis can be flexible and iterative at different stages of the process. For instance, the exploration effort on potential sectoral transition dynamics (Building block #2) could be split into two steps. A first level of understanding of potential sectoral transition dynamics may be necessary to ensure the quality of the materiality assessment (Building block #3), while a more in-depth exploration of dynamics could be carried out only for those sectors selected by the materiality assessment.

FIGURE 2: SIX KEY BUILDING BLOCKS OF SCENARIO ANALYSIS TO TAKE ACCOUNT OF THE DEEP UNCERTAINTIES OF THE LOW-CARBON TRANSITION IN DECISION-MAKING

KEY BUILDING BLOCKS OF SCENARIO ANALYSIS	HOW THIS SHOULD HELP TO INTEGRATE THE DEEP UNCERTAINTY OF THE LOW-CARBON TRANSITION
1 > FRAMING AND GOVERNANCE	**Organize the involvement of all relevant teams** to ensure the process leads to strategic integration of deep uncertainty
2 > EXPLORING OPPORTUNITY AND RISK DRIVERS AND IMPACT PROPAGATION CHANNELS	**Build understanding of complex propagation channels** of transition impacts in the real economy
3 > IDENTIFYING MATERIAL RISKS	**Focus efforts on essential areas** for further assessing the financial consequences of deep uncertainty
4 > SELECTING OR BUILDING SCENARIOS	**Handle overwhelming range of potential transition futures** by identifying a subset of relevant transition scenarios for assessing impacts on the targeted system
5 > ASSESSING IMPACTS WHILE TAKING ACCOUNT OF SPECIFIC ADAPTIVE CAPACITIES	**Integrate complex dynamics at asset-specific level** (and financial institution level) to assess net financial impacts
6 > PROVIDING DECISION-USEFUL INFORMATION ON FINANCIAL IMPACTS	**Develop decision criteria and metrics** that demonstrate the added value of information on deep uncertainty when making decisions

Note: These six building blocks are not necessarily representative of the chronological phases of every scenario analysis in practice. They should be considered rather as some key aspects of scenario analysis that are generally common to the vast array of approaches.

Source: I4CE, 2022, Scenario analysis of transition risks in finance

@I4CE_

The following section of the report discusses in more detail the identified good principles that financial institutions should seek to implement for a strategic integration of transition risk and deep uncertainty.

II. GOOD PRINCIPLES FOR A STRATEGIC INTEGRATION OF DEEP UNCERTAINTY USING SCENARIO ANALYSIS OF TRANSITION RISK

This section details the common building blocks in a scenario analysis process identified as being essential to ensure proper strategic integration of the deep uncertainty of the low-carbon transition in the context of financial risk and opportunity management.

For each building block, a sub-section introduces the aspects of deep uncertainty that the building block can help to navigate. It then details proposed good principles on what should be done specifically under this building block to properly address deep uncertainty with a strategic perspective on transition risk. In addition, a table of "guiding questions" summarizes the good principles in a checklist. It can be used by financial institutions to guide progress in their efforts undertaken in-house and/or with external service providers. It may also be relevant for a broader set of stakeholders, including supervisors, scenario developers and service providers.

To acknowledge the potential importance of granular data and analysis in the reliability of the results, this section uses examples from the analysis of complex portfolios of corporate assets (e.g. corporate equity, corporate loans) with exposure to different countries and sectors.

1 FRAMING AND GOVERNANCE ..... P. 18

2 EXPLORING OPPORTUNITY AND RISK DRIVERS AND IMPACT PROPAGATION CHANNELS ..... P. 20

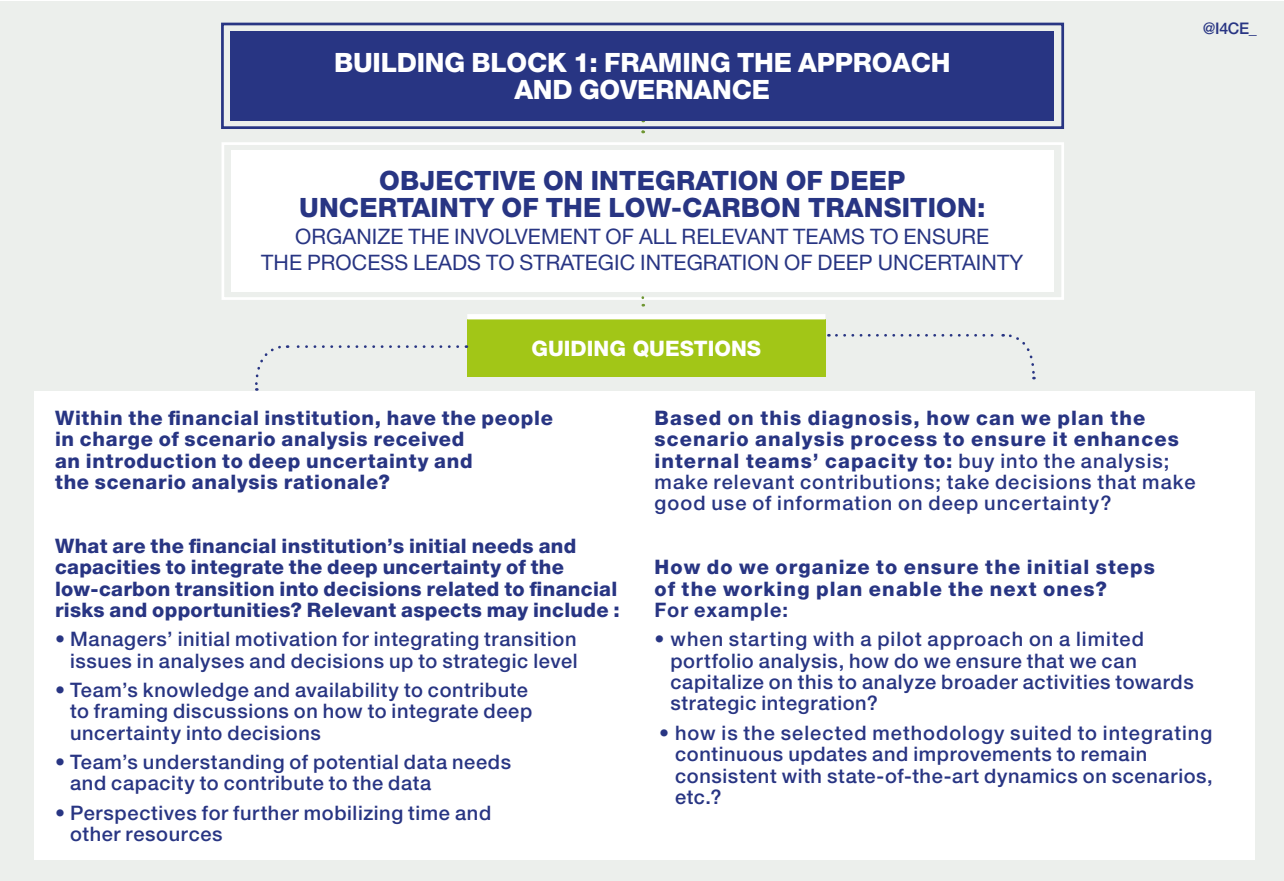
3 IDENTIFYING MATERIAL RISKS ..... P. 25

4 SELECTING OR BUILDING SCENARIOS ..... P. 28

5 ASSESSING IMPACTS WHILE TAKING ACCOUNT OF SPECIFIC ADAPTIVE CAPACITIES ..... P. 31

6 PROVIDING DECISION-USEFUL INFORMATION ON FINANCIAL IMPACTS ..... P. 35

1. Building block 1: Framing the approach and governance



1.1 WHY THIS BUILDING BLOCK OF SCENARIO ANALYSIS CAN HELP TO ADDRESS DEEP UNCERTAINTY

The true potential of scenario analysis lies in its role as a process that guides financial institutions in integrating deep uncertainty into the management of transition risks and opportunities, including into strategic thinking and planning. The initial steps taken by financial actors to frame their scenario analysis are crucial for ensuring that the process truly enables a meaningful integration of deep uncertainty into risk-related decisions.

In particular, the appropriate mobilization of teams in the different steps of the scenario analysis process is one of the key aspects to foster this strategic integration.

1.2 SOME ELEMENTS OF AN OPTIMAL ANALYTICAL FRAMEWORK FROM A THEORETICAL POINT OF VIEW

Several good principles should be applied to ensure appropriate mobilization of the financial institution's teams. First, the individuals in charge of launching discussions on scenario analysis should familiarize themselves with the concepts of deep uncertainty and how scenario analysis can help to address them. Based on this understanding, they should build plans for mobilizing the relevant teams within their institution. These could build on a diagnosis of initial knowledge, motivations and resources within the institution, and address potential capacity building needs. Moving forward, the financial actors could implement their plans with a pragmatic mindset, including a pilot approach where necessary, while anticipating the conditions for improving this approach.

A. Rapidly building capacity on deep uncertainty to enable the structuring of relevant objectives

It is important that the individuals[7] piloting the scenario analysis exercise in the financial institution begin by gaining awareness of the importance of deep uncertainty and the potential of scenario analysis to explore this uncertainty and bring added value to risk decisions.

Such an understanding may clarify the relevant objectives and characteristics to look for in a scenario analysis pro-

7. For example, individuals in charge of coordinating the scenario analysis process could belong to the risk and/or sustainability divisions of the financial institution, potentially in connection with external experts.

cess, and the implications for their own organization. This may help financial actors to understand, for example, why scenario analysis needs to explore several scenarios, why it could apply to both green and harmful activities, why it makes sense to focus on both short- and long-term horizons for a range of decisions, and why it calls for thinking on strategic resilience, etc.

To that end, financial actors could refer to this report before making plans.

B. Make plans for internal teams to build capacity and contribute to the process on risks, opportunities and uncertainties

A key to the successful integration of deep uncertainty is to plan the roles to be played by the relevant internal teams in the financial institution throughout the whole scenario analysis process. For instance, at some point, involvement of the top management is needed to drive the strategic integration of transition risks, opportunities and uncertainties. The business lines may also need skills and tools to implement the strategy. The risk and sustainability divisions may play a role in both setting the strategy and operationalizing it, with risk management policies and processes. All divisions may also contribute to addressing challenges in terms of data and the compatibility of internal analytical frameworks. Coordination with internal control functions should also be anticipated.

Such plans regarding internal organization should build on a diagnosis of the specific dynamics of the financial institution's teams. This should make it possible to determine how to mobilize the teams efficiently, while taking advantage of potential strengths in the organization and highlighting difficulties to be addressed in the scenario analysis process. The diagnosis should include an exploration of how the different teams are involved in the integration of environmental issues and in financial risk management processes, from setting the strategy to implementing it. The diagnosis should also take account of the teams' motivation, preparedness and capacity to get actively involved in the process, including a focus on management bodies.

Based on this diagnosis, the plan should be developed so as to ensure timely involvement of the teams in the different tasks. It may, for example, include training sessions to raise awareness in the teams of the relevance of transition risks and uncertainties and to build their technical capacity, as well as the recruitment of relevant profiles.

C. Anticipating whether the initial steps of the working plan enable the subsequent steps

This plan can integrate a step-by-step approach where necessary. For example, previous research by the ClimINVEST project on physical climate risk shows that the involvement of the top management may not necessarily be the first step in the process[8]. The initial step could also come from other teams, for example the sustainability and risk divisions initiating a pilot case study approach to scenario analysis on selected portfolios. The financial institutions surveyed in the ClimINVEST project reported that this approach helps to build capacity in different teams on the project and gradually demonstrates the strategic relevance of this exercise to the top management (ClimINVEST, 2021).

It nevertheless remains important to anticipate whether the initial steps actually enable the subsequent steps planned. Typically, when beginning with a case study approach, the financial institution might select a methodology that is suited to analyzing the targeted portfolios. At this stage it is important to anticipate the need to extend the analysis to other aspects of the institution's activities with the goal of achieving a strategic view. This may lead to exploring the scopes of other methodologies, identifying potential trade-offs between the scope and quality of approaches, and anticipating how internal resources can be further mobilized (e.g. to collect data on a broader scope of analysis), potentially with the involvement of external stakeholders (e.g. a range of service providers).

8. The European ClimINVEST project organized a direct collaboration between climate experts and financial institutions across Europe to identify and address the challenges of physical climate risk integration in finance. For more information on the project and public deliverables, see: https://www.i4ce.org/go_project/climinvest-tailored-climate-information-for-investment-decisions/

2. Building block 2: Exploring potential risk/opportunity drivers and impact propagation channels

2.1 WHY THIS BUILDING BLOCK OF SCENARIO ANALYSIS CAN HELP TO ADDRESS DEEP UNCERTAINTY

In the context of deep uncertainty, it is difficult to identify how the unprecedented low-carbon transition might change the dynamics in the economy, with impacts on the targeted level of analysis (e.g. the financial institution's balance sheet; portfolios and assets related to counterparties in different sectors and countries).

Scenario analysis addresses this aspect of deep uncertainty, with a structured exploration of transition dynamics that could have positive or negative impacts on the targeted level of analysis. This involves identifying the variables that are key determinants of the risk/return for the financial institution and how they can be impacted by the dynamics of the transition to a low-carbon economy – among other major economic dynamics. This may lead to investigating transition effects on the risk/return profile of counterparties in different sectors, as well as effects on macro variables (e.g. GDP, inflation, interest rates).

2.2 SOME ELEMENTS OF AN OPTIMAL ANALYTICAL FRAMEWORK FROM A THEORETICAL POINT OF VIEW

As detailed in the recommended principles below, this exploration of potential transition dynamics should consider a range of potential transition risk/opportunity drivers. In-depth

exploration is also needed of the possible propagation of the impacts of these drivers in the real economy, with distinctions to be made at the sectoral level, as well as of their possible propagation in the financial sector. The exploration should consider time horizons spanning the short to the long term.

The key to this exploration of transition dynamics and impacts at a granular level is to approach it with a forward-looking mindset. This means recognizing that transition risks and opportunities arise from an unprecedented and long-lasting restructuring of economic activities and sectors economy-wide. While dynamics from the past and identification of long-lasting heavy trends can provide a good starting point, it is important to recognize that the transition will not look like an extrapolation of the past. Thus, the exploration should emphasize how the unprecedented transition dynamics may reveal specific vulnerabilities and lead to the remodeling of activities and sectors economy-wide.

A. The exploration of transition risk drivers must go beyond carbon pricing

Carbon pricing policy – and in particular the carbon tax – is usually the first transition risk driver that is mentioned[9]. This is not surprising, as economic theories have presented carbon pricing at the global level as the most efficient policy to drive the low-carbon transition[10]. However, transition risks may arise from a broader set of driving forces that broadly overlap with the drivers of the low-carbon transition. Identifying these drivers is important for a risk and opportunity analysis of portfolios, as each driver may have different impacts on the economy and call for different transition strategies.

The set of climate policy risk drivers goes beyond carbon pricing

A broader set of climate-related policies should be considered. Governments have also been using other policies, including for example standards on energy efficiency in buildings or industrial installations. Financial regulators are also developing a range of approaches, including disclosure requirements on climate-related issues. For instance, the European regulators are currently developing sustainability-related corporate disclosure standards that will require companies to explain in detail their "transition plans" (EFRAG, 2022). In the future, companies that fail to comply with these requirements might be sanctioned by financial supervisors, or suffer reputational impacts or an increase in their cost of capital.

As the deployment of carbon pricing policies has faced difficulties in practice (for example with the "Yellow Vests" protest movement in France), the importance of this broader set of climate policy tools may remain significant in the future (IMF, 2021). These tools may encompass different levels of risk. Policy alternatives to carbon pricing might be appropriate for limiting global warming to below 2°C, but they would need to be more aggressively implemented (IMF, 2019). This may result in higher financial risks of losses in the economy.

Other transition risk and opportunity drivers: technologies and behavioral change

As shown in Figure 3, beyond climate-related policies, other transition risk drivers may have a very significant impact on the economy[11].

The technology risk driver refers to technological innovations or improvements that foster the emergence, decline in cost and increased deployment of solutions that support the transition to a low-carbon economy. For example, technological change can encourage the scaling up of energy efficiency in industry and buildings, renewable energy sources, battery storage, and carbon capture and storage (CCS). The timing of emergence, cost reduction, development and deployment is also part of this uncertainty. These changes may affect the competitiveness of certain actors in the market, their production and distribution costs, and ultimately the demand for their products and services. (TCFD, 2017)

The behavioral change risk driver refers to the change in economic agents' behavior regarding climate issues. First, economic agents may give greater economic value to activities that are compatible with a low-carbon economy. Where consumers are concerned, this may result in new consumption trends, leading to a shift in demand for services and products, with potential consequences for the validity of the whole supply chain of companies, and subsequent cascading effects across economic sectors. Companies may also decide to modify their products and services, leading to changes in market offering. All of this may question the validity of companies' current supply chains, with subsequent cascading effects across economic sectors. It may also lead to changes

9. GHG emissions trading schemes are another key tool used to put a price on carbon.

10. Other policies, such as environmental standards on specific boilers, may provide little flexibility to companies that were planning to amortize their boilers over a longer period but will need to do so earlier in order to comply with the efficiency standard.

11. The present report considers "policy, technology and behavioral transition risk drivers". This is consistent, for example, with EBA (2021). However, a broader range of transition risk drivers is mentioned in the literature, such as "liability/litigation risks", "reputational risk", or "market risk". There is no generally stabilized typology of these transition "risk drivers", "risks" or "risk factors". The choice may depend, for example, on the broader typology of risks one has in mind. The present report defines "risk drivers" that are at the root of the propagation of impacts in the real economy and the financial sector. It considers that the broader set of risk drivers mentioned above in this footnote can be seen as the consequence in the economy of the policy, technology and behavioral transition risk drivers, combined with other major evolutions that are not directly related to the transition (e.g. a "market risk" on the cost of battery production may arise from the limited availability of necessary input materials, regardless of transition efforts).

in specific input needs for their production process (e.g. "rare earth" chemical elements for electric car engines), highlighting resource limitations with consequences for input prices, etc. As regards the financial sector, investors may, for example, shift their perception of the transition and reprice companies according to their strategy to increase resilience or to contribute to the low-carbon transition of the economy.

Second, the behavioral change risk driver also includes communications and campaigns launched against those economic actors that are considered as transition laggards, with potentially harmful consequences for their reputation. This may lead, for example, to reduced capacity to recruit appropriate employees, limited capacity to build partnerships, a reduction in goodwill, and changes in conditions of access to capital[12].

Third, it also includes actions that seek compensation for loss from people and institutions that foster activities that are harmful to the low-carbon trajectory[13].

The significance of each transition risk driver is not the same for all assets. In particular, it depends on the sectoral and regional characteristics of the activities under analysis

B. The exploration of potential types of impacts needs to take account of complex propagation channels up to the sectoral level

Regardless of the level of analysis targeted by the financial institutions, it is recommended that they rely on an exploration of the transition consequences at the level of economic activities, where the changes may occur in the first place. This may reveal a range of vulnerabilities that vary according to the economic sector.

The resulting impacts to be considered go beyond stranded assets in fossil industries

Historically, stranded assets in the fossil fuel exploration and extraction industries were the first potential transition impacts to be discussed in the pioneering work by Carbon Tracker (2014). In a nutshell, Carbon Tracker's models show that a 2°C world requires a cap on the amount of fossil fuels that can be burnt, and hence a cap on the demand for fossil fuel extractive industries. The cap – represented by an inelastic demand – intersecting with the merit order of producer costs would lock-in fossil fuel prices. This would preclude sales from companies with extraction costs higher than these prices, and their reserves would become stranded assets. This should have consequences for the valuation of assets and the pricing of these companies' shares on financial markets. While stranded assets in fossil industries are a key transition issue, they should not overshadow the broader picture of transition impacts in diverse sectors.

Corporate counterparties can be impacted by the transition on different aspects of their balance sheet (valuation of assets, debt and equity profile and conditions of access to additional funds), income statement (volume and price of sales; operational expenditures; existing, committed and planned capital expenditures) and cash flow statement. This may have consequences for the companies' capacity to fulfill their commitments to investors and banks, and could impact insurance claims.

In addition, it is important to consider analyzing the risks and opportunities of counterparties operating in a broad range of sectors. This includes high-emitting activities that are not fossil-fuel extractive industries; activities that are not beneficial to the low-carbon trajectory through their value chain; but also "sustainable activities" that might be competitive only in a subset of possible low-carbon transitions.

Several propagation channels should be explored for a given financial impact category

A given financial impact category may arise from multiple dynamics. For example, a company's revenues may change as a result of different impact channels. A cement company using techniques that are less emitting than the sectoral average could be exposed to an increase in demand from the building industry, driven by demand for lower-carbon building materials. This may also have an impact on the price of this "low-GHG cement". A reduction in demand for all types of cement may also arise from a generalized economic downturn, again with consequences for the sales price.

A company could also be exposed to an increase in operating costs from a carbon price; it may then seek to pass through the cost to consumers with a higher price, resulting in an adjustment in demand and effective price, etc.

The exploration of risk propagation channels should reflect sectoral characteristics

The key performance drivers of companies and their vulnerability to the transition drivers can differ across economic activities. As mentioned above, the transition risk impact channels will not be the same for fossil fuel extractive industries and the cement industry.

12. In other transition risk typologies, this is called "reputational risk".
13. In other transition risk typologies, this is part of "liability risk".

Another illustration is certain transition issues for car manufacturers. For example, they can be exposed through the characteristics of their car products. Improving the fuel efficiency of car engines may become an increasingly material issue if efficiency standards continue to rise, or if consumers are more sensitive to this when buying a car, potentially due to carbon pricing applied to car fuel prices. The development of zero-carbon powertrains can also be a differentiating factor for sales, influenced by demand or by policies that progressively jeopardize the production of petrol and diesel cars. The pace of emergence of specific car engine technologies (e.g. different electric batteries, hydrogen engines) on markets is then a key issue. Changing patterns of mobility can also evolve in relation to the low-carbon transition and broader trends, such as car-sharing habits, urbanization and associated car-ownership patterns. Car manufacturers may seize opportunities to develop new models and services corresponding to these changes (ET Risk project, 2017)[14].

The impact propagation channels are therefore different between sectors, from the risk driver to the range of impacted variables (e.g. the number of cars sold per powertrain and battery costs etc. for car manufacturers; coal, oil and gas prices for fossil fuel extractive industries) and all the way to the company's financial performance.

The risk propagation channels should take account of complex dynamics across the economy

Understanding of transition dynamics – even in a single sector of interest – may benefit from an analytical framework that takes account of interdependent dynamics across sectors, from the micro to the macro level, as summarized in Figure 3. Providing an integrated picture of these interdependent dynamics is particularly justified in the context of scenario analysis, as it is one of the expected strengths of this approach compared to sensitivity analyses or other techniques.

The transition produces dynamic change at multiple levels (sectors, macro), with cascading effects across these different levels. Transition risk can spread from one sector to another. This goes beyond the influence of higher energy costs on other sectors. For example, a steel company may see its demand from the car manufacturing industry decline because of emerging competition with manufacturers of low-weight composites such as carbon fibers (ET Risk project, 2017). Transition impacts on a sector may also interact with impacts at the macro level. For instance, countries may change their international trade strategies in the context of the transition. They may decide to apply cross-border carbon taxes on specific products; other countries may retaliate momentarily with protective measures. Other evolutions not directly related to transition dynamics may amplify or reduce transition impacts on international trade. Among the multiple possibilities, a rise in populism may favor local trade with lower emissions from logistics, while also encouraging the use of local fossil fuel reserves, or raise geostrategic questions on key international supply chains (e.g. on rare earths or gas), etc.

Feedback loops across sectors – including the financial sector – may also amplify or reduce the propagation of transition impacts. For example, in the future the expectations of financial market participants may converge on a new perception of transition risks for different types of assets. This shift in "market sentiment" may occur on any time horizon, in a sudden, unanticipated manner, leading to rapid repricing of financial assets. This would have feedback consequences for the conditions of access to capital for the underlying companies. Ongoing research seeks to clarify transition risk perception in the financial sector, as well as the conditions for a shift in market sentiment and its consequences (Dunz et al., 2021; Battiston et al., 2021).

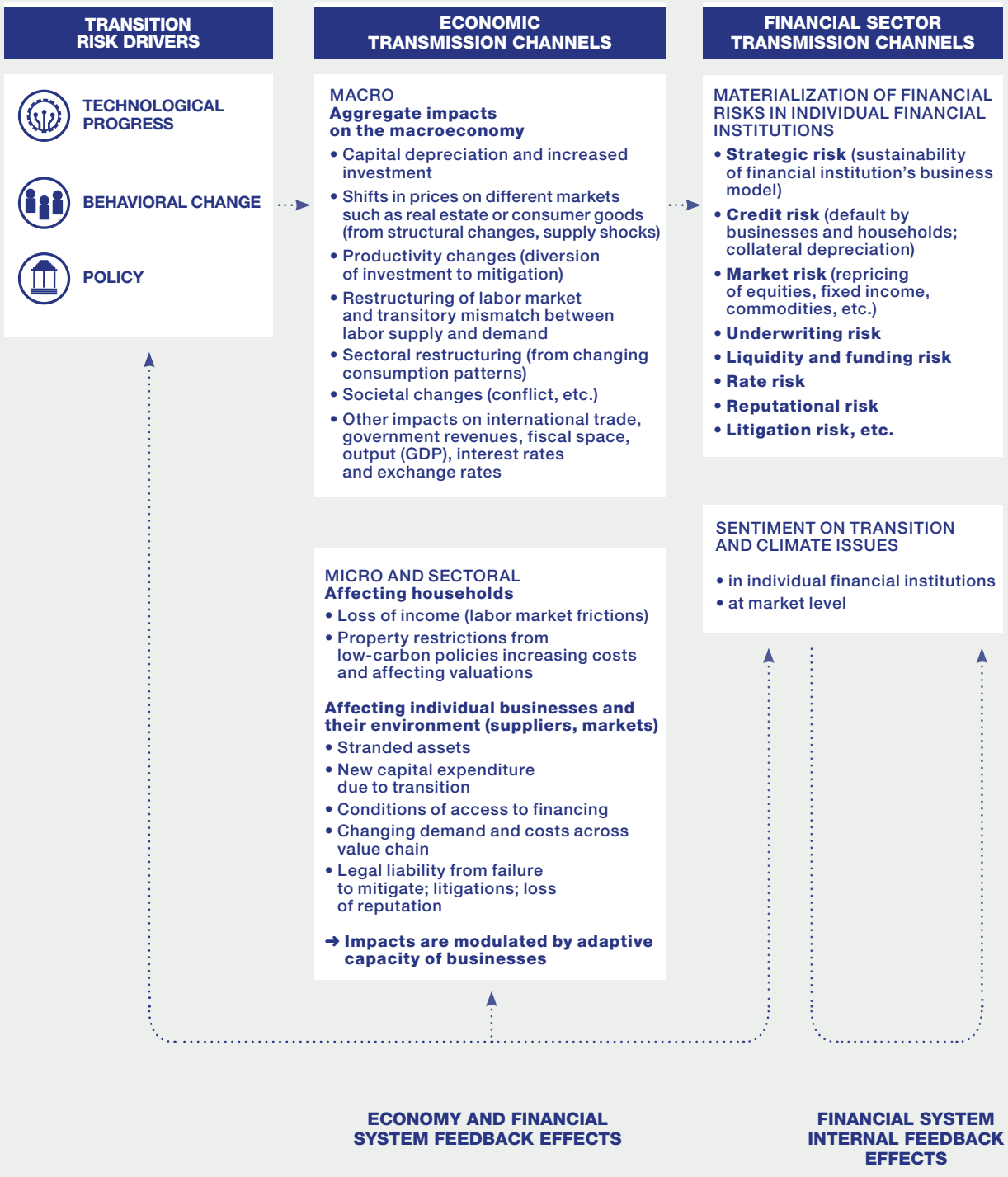
C. The exploration effort should take account of short- and long-term dynamics

A relevant strategic approach to transition risk requires exploring the potential dynamics over a long-term horizon, meaning at least a decade. This holds true even where this might be longer than the time horizon of the resulting strategic planning selected by the financial institution.

First, certain dynamics that are believed to occur in the long term may call for immediate concrete action. For instance, financial actors may consider that individuals or organizations might hold the financial institution responsible for contributing to climate impacts through a lack of alignment of their activities with efforts to decarbonize the real economy. In light of this information, some financial actors may want to take action to align their activities with the objectives of the Paris Agreement in the short term. An exploration of long-term dynamics may also highlight some potential market development opportunities, calling the financial institution to make efforts in the short term to establish a monitoring system to anticipate weak signals about such opportunities. In the context of their portfolio management, financial institutions may also want to know which of their counterparties are themselves heading towards strategic dead-ends. A first step to clarify this is to extend the sectoral exploration of transition dynamics to long-term horizons.

14. The general picture of sectoral dynamics might also change depending on the country, for example the regulation of the energy sector may be framed in different ways across countries. From this perspective, this may call for considering certain country dynamics at this stage of the analysis.

FIGURE 3: IMPACT PROPAGATION CHANNELS OF TRANSITION RISK FOR THE FINANCIAL SECTOR THROUGH THE REAL ECONOMY



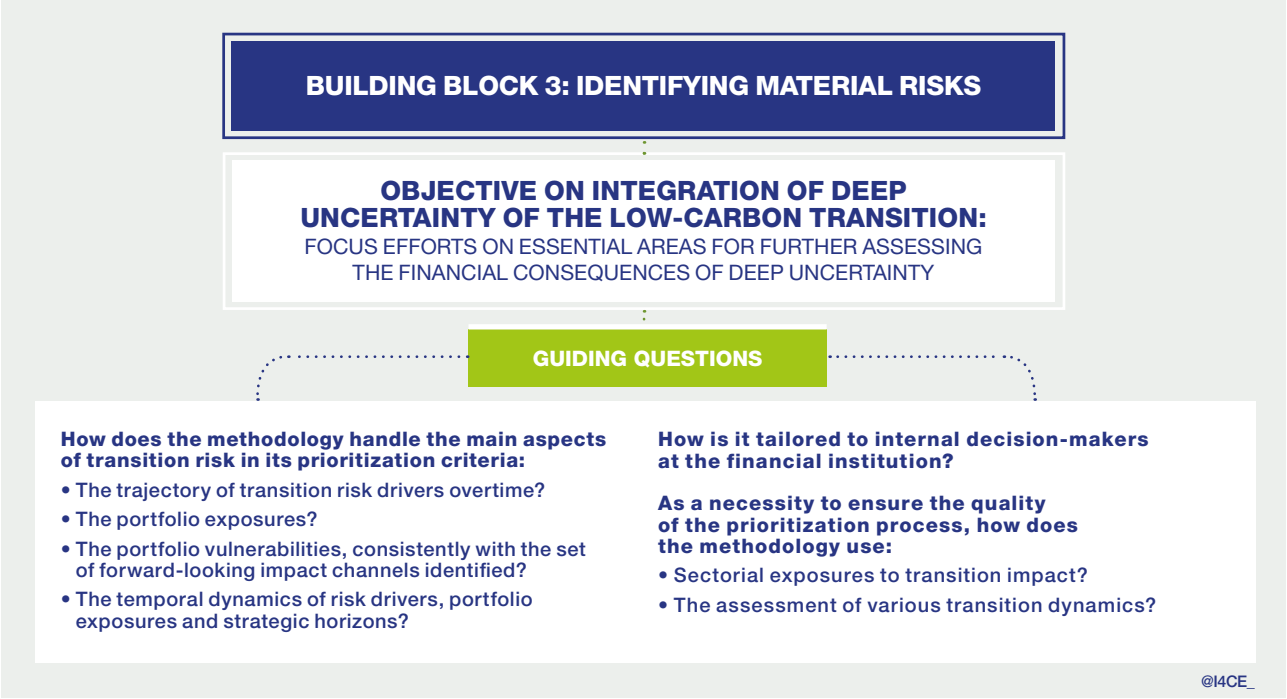
Source: adapted from NGFS (2020) Climate Scenarios for central banks and supervisors

@I4CE_

Moreover, the dynamics of the low-carbon transition have already begun. The consequences of climate policies and other drivers of a low-carbon transition are materializing and can generate financial impacts now.

Finally, there is also uncertainty about the timing of certain changes. As explained above, shifts in market sentiment could occur at any time.

3. Building block 3: Further steps of materiality assessment



3.1 WHY THIS BUILDING BLOCK OF SCENARIO ANALYSIS CAN HELP TO ADDRESS DEEP UNCERTAINTY

As described in section II.1, the second building block of scenario analysis organizes a forward-looking exploration of potential impacts in a structured manner, guided by the objective of identifying potential impacts on the real economy down to the financial institution. In the context of deep uncertainty, this exploration effort is necessary, since it helps to determine relevant types of impact channels that can be considered for further assessment.

However, it may not be essential that further assessment focuses on the complete set of potential impacts identified. A subset may be enough, depending on the characteristics of the institution's portfolios and the potential evolution of risk drivers. Finding a way to prioritize the key aspects can be an efficient practice per se to navigate the complexity of potential transition futures and impacts that characterizes deep uncertainty. This can also be a technical necessity, as further assessment of complex transition impacts on large portfolios can be daunting due to resource and time constraints. Indeed, further steps in the in-depth analysis of potential impacts under different scenarios are necessary, as detailed in section II.3 onwards.

In this context, this building block of materiality assessment should ensure the feasibility of further analysis through a reasonable selection of the scope of analysis. It is particularly important to clarify the relevance of criteria used in this prioritization process. Otherwise, the scope of analysis of deep uncertainty could significantly lose relevance.

3.2 SOME ELEMENTS OF AN OPTIMAL ANALYTICAL FRAMEWORK FROM A THEORETICAL POINT OF VIEW

Building on the identification of potential transition impact categories, the assessment of material risk exposures identifies the "most important" portfolio exposures to "key" risks. This process can rely on a number of potential prioritization criteria that should follow at least the three principles detailed below: prioritization criteria should be made transparent, customizable, and relevant to identifying unprecedented transition impacts.

A. Prioritization criteria should be transparent and allow for customization to a certain extent

The prioritization criteria can focus on several drivers of the potential impacts on portfolios. As illustrated in Figure 4, the criteria may relate to key building blocks of a risk analysis, including the risk drivers, exposure, vulnerability and dynamics over time.

The risk materiality may depend on the selected transition risk drivers and their potential magnitude over time (e.g. the carbon price trajectory). This raises question about how to choose the relevant range of potential magnitudes.

The materiality assessment also requires identification of the most relevant portfolio exposures (or expected future exposures in line with portfolio development strategies) in order to conduct an in-depth analysis. This can typically include considerations about portfolio size compared with the total size of the institution's activities.

The materiality also depends on the vulnerability of portfolios to the risk drivers, which describes how serious the impacts could be if the risk drivers materialize on the exposed portfolios. This may include the adaptive capacity of counterparties in different sectors. This selection of vulnerabilities may depend on the set of risk drivers and potential impact channels considered. The appreciation of the vulnerability levels may depend on the nature of the historical and forward-looking data used.

Temporal aspects are also key to determining the set of material risk exposures. For instance, a financial actor may give importance to the overlap or mismatch between the expected horizons of risk driver materialization and the expected holding period of the asset or time horizon of valuation. A financial actor may also decide to take account of long-term impacts, for example from the perspective of developing strategic choices.

It is important that service providers and/or internal teams ensure transparency for internal decision-makers on these criteria – or any other relevant ones – used for prioritization. Indeed, the chosen criteria, their construction and their relative weight all change the scope of the analysis, with consequences for the interpretation of results.

In addition, to some extent, the choice and relative weight of criteria depend on the objectives and strategies of users in the financial institution. Service providers should therefore allow financial actors to take part in the framing process.

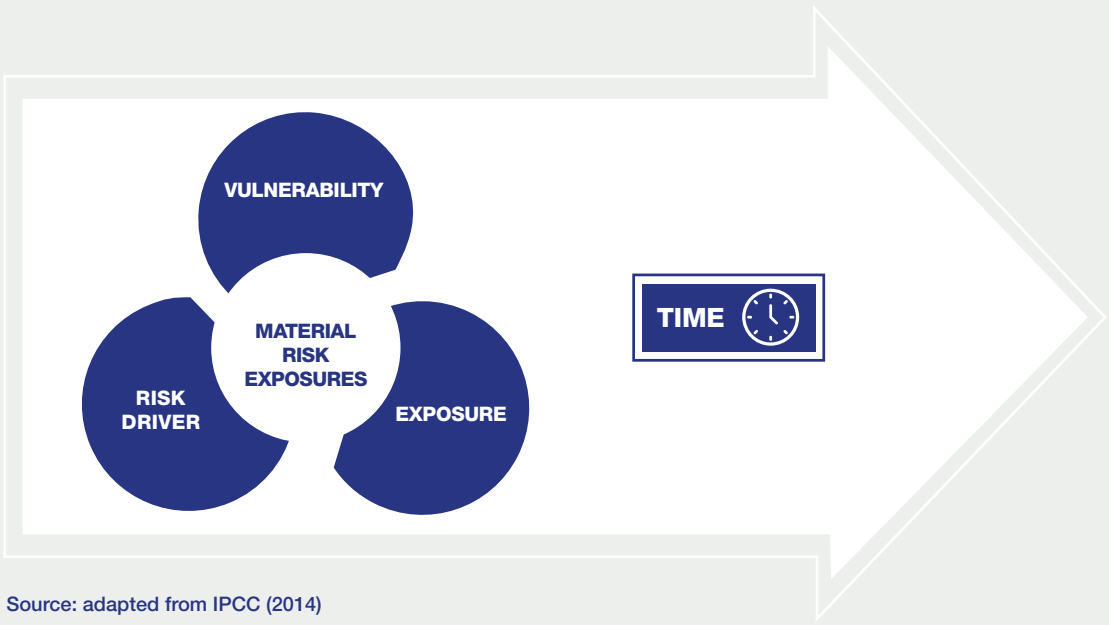
Nonetheless, regardless of who is involved, the technical guidelines described below should be observed for the definition of criteria. This is necessary to ensure that materiality assessments do not undermine the relevance of the scope of analysis.

B. Prioritization criteria must follow certain principles to preserve the robustness of the overall analysis

Classifying portfolio exposures based on underlying activities in the real economy

Portfolio classification at the asset class level is not appropriate to identify the potential pockets of vulnerabilities. As explained in section II.2, the financial asset's vulnerabilities may vary considerably depending on the sectoral exposure

FIGURE 4: EXAMPLE CRITERIA TO IDENTIFY MATERIAL RISK EXPOSURES



Source: adapted from IPCC (2014)

@I4CE_

of underlying counterparties. This sectoral vulnerability framework is also essential to connect the dots with the selection of risk drivers liable to generate material impacts on the different sectors. This raises the need for reliable data on sectoral exposures of portfolios.

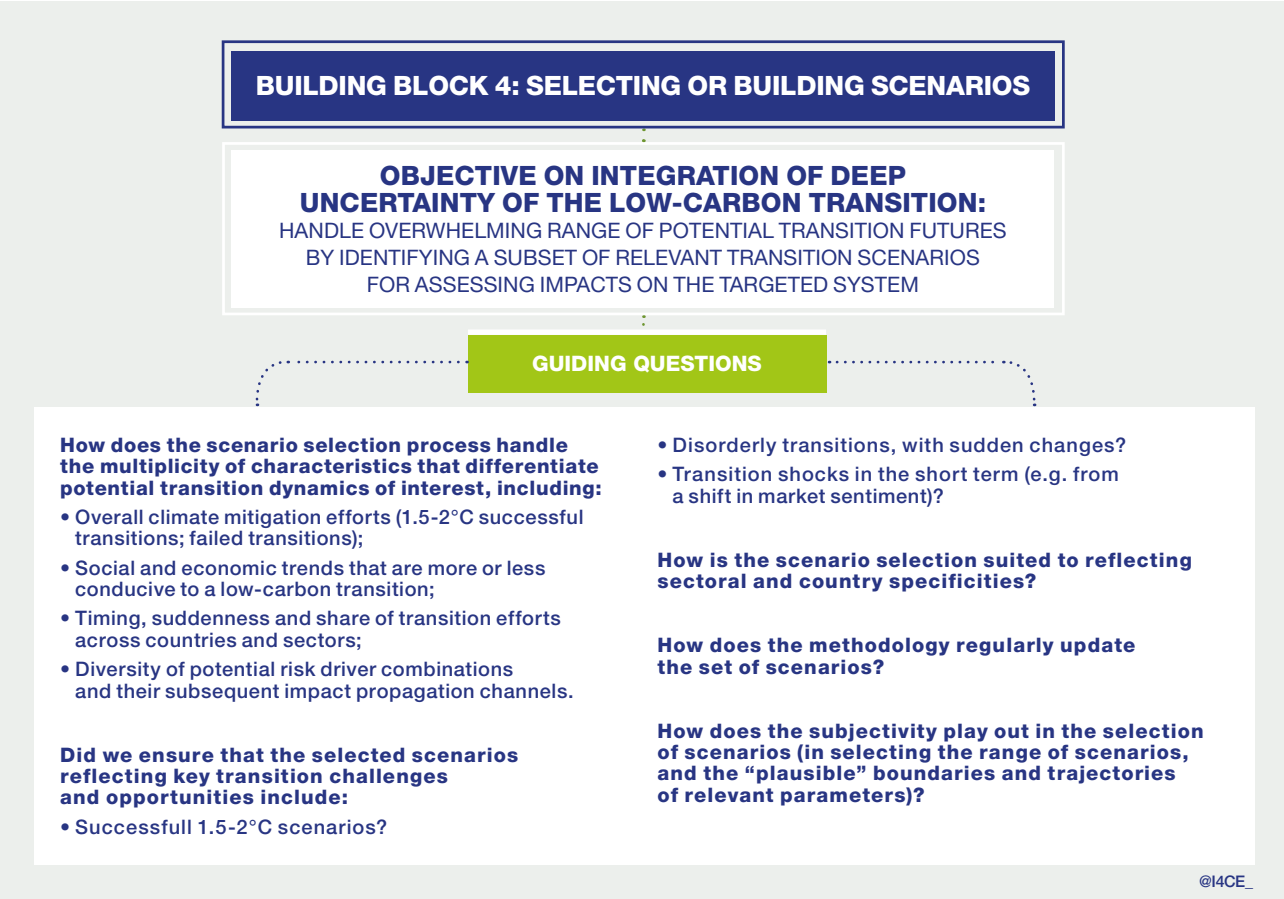
The sectoral view is also key to identifying cross-asset class exposures and realizing that the combination of small portfolios per asset class may reveal high exposure to specific sectors with high vulnerabilities.

Testing for materiality of different transition dynamics selected objectively

Each sector can be affected differently by specific impact channels, materializing with different combinations of risk drivers, with different magnitudes, in different contexts, over different timelines, etc. It is therefore good practice to test for materiality of risk exposures in several transition dynamics that may highlight different sectoral risks and opportunities. Further detail is provided in section II.4 on selecting a set of scenarios.

In addition, the selection of scenarios should not be driven only by the user's subjectivity, for example the user's preferences concerning the type of transition they would like to happen, or their personal beliefs about the potential range of evolutions in risk drivers (e.g. on the relevant range of carbon prices and its evolution over time). Other objective techniques can play a role in selecting the relevant range of transition dynamics to identify material risk exposures. Further detail is provided in section II.4 on selecting a set of scenarios.

4. Building block 4: Selecting or building scenarios to assess potential impacts in a range of key plausible futures



4.1 WHY THIS BUILDING BLOCK OF SCENARIO ANALYSIS CAN HELP TO ADDRESS DEEP UNCERTAINTY

Based on the material risk exposures identified, the scenario analysis process seeks to assess the potential financial impacts in a range of alternative futures[15].

From this perspective, the transition scenario selection process addresses an essential aspect of the deep uncertainty of the low-carbon transition, that is the potentially infinite number of possible transition futures. Due to the unpredictability of the future transition dynamics that will materialize, a large number of transition scenarios could be considered and they cannot be assigned with an objective likelihood. However, decision-makers will need to boil down these potentially infinite cases to a limited number of scenarios that are the most relevant for risk/opportunity assessment of their portfolios, to enable them to make decisions based on this.

In this context, the scenario selection process seeks to identify a limited number of key scenarios that reflect key issues for the financial institution in a reasonable range of possible futures.

The scenarios should allow for further assessment of impacts in the real economy, which is usually conducted first at the macro/sectoral level, then at the counterparty level. Some of the scenarios include the assessment of sectoral impacts. Their capacity to do so appropriately is therefore discussed in this section.

4.2 SOME ELEMENTS OF AN OPTIMAL ANALYTICAL FRAMEWORK FROM A THEORETICAL POINT OF VIEW

The principles below are relevant to ensure that the scenario selection process efficiently takes account of the range of uncertain transition futures.

15. The objective is not to focus on the most desired transition scenario from the point of view of the financial user (for example the targeted trajectory for a portfolio alignment strategy). Scenario analysis seeks to take account of the broader range of potential transition futures and their consequences in terms of risks and opportunities for the financial institution.

A. Selecting scenarios to analyze portfolio resilience to different types of transition efforts

Including at least 1.5°C to 2°C scenarios

Several scenarios should be used according to their level of global climate ambition. The targeted climate outcome of a successful transition can vary (typically from 1.5°C to 2°C, as can be interpreted from the Paris Agreement) and lead to different pressures on the real economy.

Including at least 1.5°C and 2°C scenarios in the final set of scenarios makes sense for transition risk analysis. These scenarios may encompass a high level of pressure for economic restructuring. A risk and opportunity analysis in the context of such scenarios is also a useful complement in the broader context of financial actors' efforts to contribute to the low-carbon transition. It can also be useful to include other scenarios with transition efforts that fail to limit global warming to below 1.5°C or 2°C, if these scenarios provide interesting insights on transition risks and opportunities for the institution.

Diverse scenarios can be considered for a given global warming limitation objective

Several scenarios can also be used for a given targeted climate objective, to represent the diversity of key transition impact channels identified in the previous steps. For example, a 2°C transition pathway can imply different combinations of transition efforts. The transition risk drivers (policies, behavioral change, technological progress) can be assigned with different relative weights, which may put pressure on different aspects of sectoral business environments. The models used to generate transition scenarios can also vary in their representation of how economic systems provide a dynamic answer to the pressure from transition risk drivers, at the macro, inter- and intra-sectoral levels, as introduced by I4CE (2019b).

Ideally, the analysis should also consider the different potential evolutions of the broader dynamics of the socioeconomic context (e.g. heavy trends, background changes that are more or less conducive to a low-carbon transition). This would call for another level of scenario multiplicity.

B. Disorderly transition scenarios are key to highlighting potential challenges on various time horizons

Disorderly transition scenarios are essential, since they can be particularly conducive to plausible financial risks, as seen in the NGFS scenarios (NGFS, 2020). These represent transitions with sudden, unanticipated changes that could leave some economic and financial actors with limited capacity to adapt.

These sudden impacts can appear on a range of time horizons. Disruptions may emerge in the long term, with delayed action for the transition. For instance, they could begin as economic agents realize that the climate ambition is getting out of reach, or in response to climate impacts that keep worsening in the long term.

Disruptions may also appear in the short term, for instance as a result of shifts in market sentiment about the risk/return profile of specific activities in the context of the low-carbon transition. For example, the increasing number and severity of climate impacts – as we have already begun to observe in recent years – may lead to the feeling of a need for more imminent action on the transition. This may increase exposure to potential impacts within the expected holding period of assets in financial institutions. For its transition stress-testing exercise in 2018, the DNB also used a set of four transition scenarios with shocks materializing in the next five years, respectively from policy, technology, policy/technology combined, and market confidence (DNB, 2018).

The perspective of disruptions over the short to longer term may have strategic implications for financial institutions, as well as other operational consequences (for example, valuations through discounted cash flow models are supposed to integrate impacts on cash flow sequences over the long term – potentially modeled as a terminal growth rate).

C. The scenarios should be made suitable for analyzing key transition impacts on different sectors and country exposures

The scenarios are based on models that assess the macro and sectoral impacts of a low-carbon transition. As such, they are a key starting point in the scenario analysis process for analyzing transition impacts at the macro and sectoral levels[16].

This calls for several points of attention on the representation of sectoral dynamics in the scenarios. First, the scenarios should represent the key sectoral impact propagation channels identified in the previous building block. Second, financial actors should check whether the models provide the variables that are relevant and necessary for carrying out risk and opportunity assessments in each sector.

In addition, granularity at country level can also be relevant in terms of modeling economic dynamics and in terms of

16. And this assessment will be pushed further at the counterparty level in subsequent steps of the scenario analysis process, as described in the next building block (see section II.5).

output variables. Indeed, the relevant sectoral chains of impacts may differ from one country to another. For instance, sectoral import/export dependencies can be country-specific. The relevant sectoral impact channels may also depend on political and regulatory frameworks (e.g. regulated vs. deregulated markets; trends in policy support for the deployment of specific technologies or industries may change the current competitive environment as well as perspectives of policy risk drivers in that sector). The updated national low-carbon trajectories may also provide updated inputs to differentiate assumptions on policy risk drivers across countries and sectors. The selected scenarios should therefore integrate or enable integration of these specificities at the country level.

Previous research from the ET Risk project also points to the need for scenarios to provide relevant time intervals for risk/opportunity assessment of portfolios. They suggest that a five-year time interval is not enough for risk and valuation models (ET Risk project, 2017).

D. Regularly updating scenarios

Scenarios can rapidly become outdated. For example, they include assumptions on the cost evolution of power-generating technologies, batteries, etc., which may prove wrong in practice, and they therefore need to be updated regularly. New policy strategies (e.g. updated NDCs and clarifications of policy mix), new behavioral patterns, etc., may also emerge over time and be considered in revised scenarios.

E. The selection process should favor objective choices while clarifying the remaining role of subjective choices

As explained above, the transition scenario selection process should rely primarily on objective criteria and the use of the best technical capacities available to model consistent and plausible transition scenarios[17]. From this perspective, financial actors should familiarize themselves with the key aspects of the integrated assessment models (IAMs) used to generate scenarios[18].

However, some level of subjectivity will most likely remain in the selection process of a limited number of scenarios. Even the "science-based" practices to generate scenarios involve some assumptions that are subjective per se. This applies to the most renowned IAMs. Setting the relevant boundaries of variation (in terms of upper and lower bounds, and dynamics over time) to explore for risk drivers and other uncertain parameters in these models involves some level of subjectivity from the modelers, as it may not be possible to predict how fast and how far these parameters could evolve.

The technical choices under the modeling of key scenarios should thus be explained, including with regard to their subjective aspects.

A good practice to deal with subjectivity may be to consider the sets of scenarios that arise from documented and dedicated work combining the efforts of many stakeholders, while acknowledging that their assumptions can still be challenged and improved (e.g. on the modeling of macro consequences, including GDP). This may include scenarios developed by the NGFS.

17. The selection process should not primarily rely on subjective choices, such as personal beliefs about what the transition might or should look like.

18. For instance, assumptions on the evolution of technologies can be made at different levels of the modeling process. The availability of carbon dioxide removal technologies (CDR) over time can be given as an input assumption in the model to generate a specific scenario. The same model may also include assumptions on availability and costs of other energy-related technologies, and these assumptions are therefore reflected in every scenario generated by this model.

5. Building block 5: Taking account of specific challenges and adaptive capacities when assessing transition impacts

5.1 WHY THIS BUILDING BLOCK OF SCENARIO ANALYSIS CAN HELP TO ADDRESS DEEP UNCERTAINTY

The previous building block of scenario analysis selected a range of key scenarios. These served as a basis to assess potential impacts on a large scale, including at the macro and sectoral levels by country.

In the context of deep uncertainty, the macro and sectoral analysis may not be sufficient to characterize the financial institution's net exposure to financial impacts from the low-carbon transition. Counterparties in a given sector may face specific challenges and develop a specific capacity to ensure timely financial adaptation to a range of low-carbon transitions in many ways. This intra-sectoral variability may have significant consequences on the financial institution's exposure to the financial risks and opportunities of the transition.

Similarly, as part of the scenario analysis process, financial institutions may potentially want to factor in their own adaptive capacity or, in other words, their strategic response to one or several transition scenarios.

5.2 SOME ELEMENTS OF AN OPTIMAL ANALYTICAL FRAMEWORK FROM A THEORETICAL POINT OF VIEW

The principles below provide recommendations on how to take account of the adaptive capacities of the counterparties and of the financial institution itself, while assessing net transition financial impacts.

A. Taking account of the counterparty's specific challenges and capacity to adapt

The net level of impacts may depend on several key specific characteristics of the counterparty, also taking account of its broader sectoral and macro context. Such characteristics may include the counterparty's transition challenges. They define the counterparty's need for adaptive capacity, whose characteristics should also be explored. The counterparty's challenges and adaptive capacity are a complex issue and there is no single framework to characterize them.

The counterparty's challenges

As illustrated in Figure 5, the challenges of the company depend partly on its current situation and outlooks. They can be defined first by how the company's key performance drivers are exposed to and sensitive to transition risks through its different activities and the geographical implantation of its value chain. Second, the company's transition challenges may vary if it has already implemented the first steps of its transition dynamics. Third, the magnitude of the challenges may also depend on the anticipated lock-ins in the company's business trajectory. For instance, an oil and gas company may have already engaged in some new exploration projects with corresponding capital expenditures. This locks-in the company's future need to exploit the resulting oil and gas reserves and leads to an increased exposure to the risk of unprofitable exploitation (stranded assets).

The analysis of the company's challenges should also take account of its broader business and competitive environment. This implies understanding how the company is positioned in its environment, as well as the outlooks of business partners, sectoral peers and intersectoral issues.

The company's challenges may also depend on the range of scenarios considered, and how they interact with company-specific characteristics. For instance, assumptions about the timeline of risk driver materialization influence the effective impacts on the company, depending on its specific lock-ins over time.

Three main aspects of the counterparty's adaptive capacity

The challenges drive the counterparty's adaptive capacity needs. The following paragraphs propose emphasizing three main aspects in the analysis of the counterparty's adaptive capacity.

As illustrated in Figure 5, the first proposed aspect is identifying potential solutions for adapting to transition impacts. This should provide information on the existence of plausible solutions that the counterparty could mobilize, at least in theory. The identified solutions may have different degrees of maturity, and variable relevance depending on the scenario that will materialize.

The second aspect concerns the resources for adaptive capacity that the company already possesses. This gives a sense of the counterparty's current strengths and the resources that it can mobilize to implement different types of adaptation solutions relevant in one or several transition scenarios.

The third aspect is the counterparty's strategic dynamics on transition risks and opportunities. This is essential for the counterparty to effectively prepare itself to manage transition risks and opportunities, with appropriate solutions and resources (already acquired or yet to be developed). The transition risk strategic process should build on the counterparty's own scenario analysis of transition risks and opportunities to develop transition-resilient plans. This information may help financial actors to appreciate the robustness of the counterparty's whole strategic process. As illustrated in Figure 5, it may lead to exploring several aspects of the transition risk strategy, including its consistency with the overall business strategy, its quality and maturity, and the counterparty's capacity to implement the strategy and to update it over time.

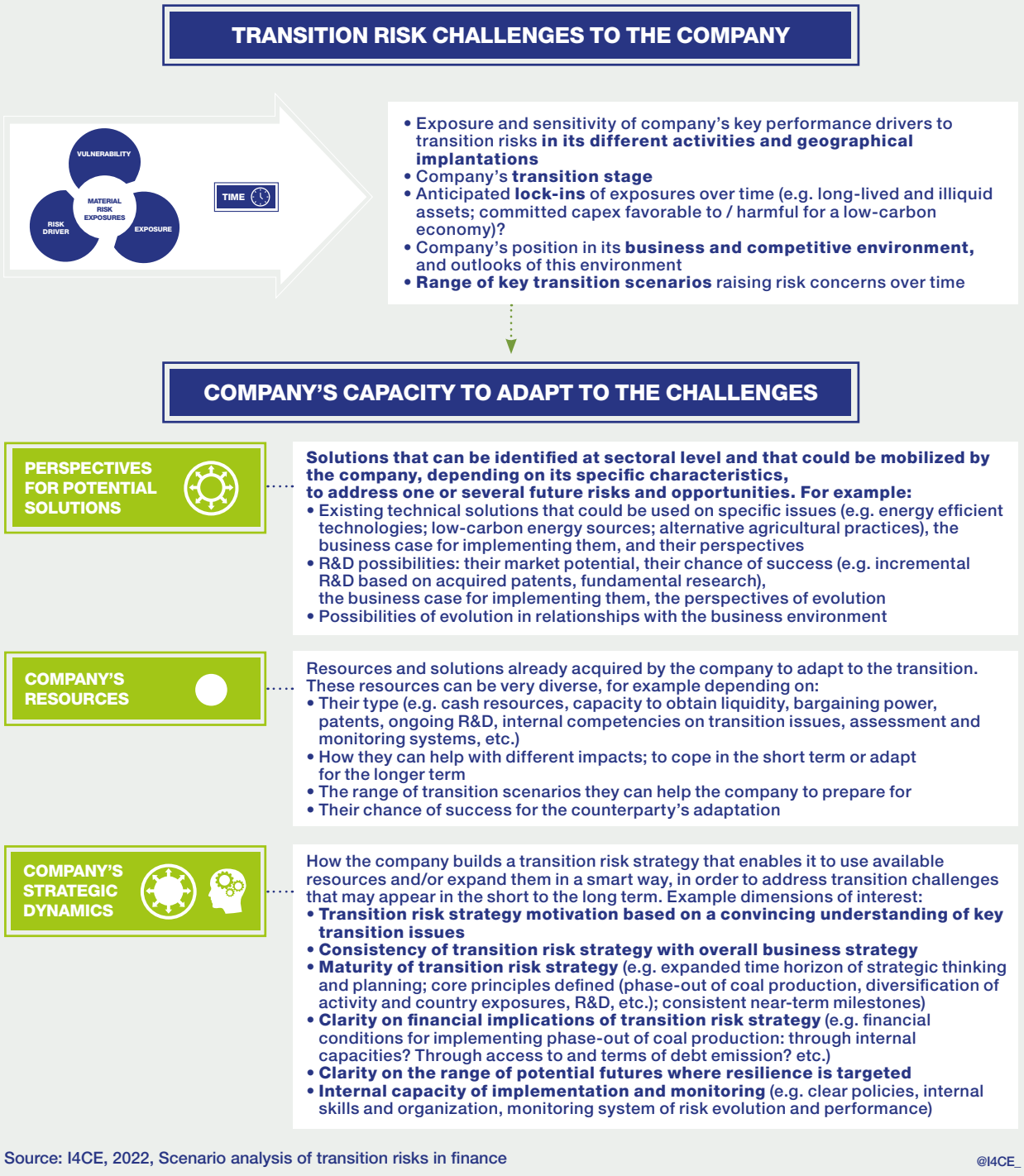
Some specific points of attention about the counterparty's transition risk strategy

As part of the transition risk assessment, financial actors may want to learn more about the counterparty's broader strategy to align with the objectives of the Paris Agreement. The counterparty's transition risk strategy – seeking to adapt financially to the transition – does not provide the same information as its alignment strategy. For example, a counterparty may potentially seek financial resilience by capturing the last fossil fuel business opportunities. This additional information on the counterparty's alignment strategy can be useful for financial actors in the context of their financial risk analysis. It helps them to appreciate the consistency of the counterparty's transition risk strategy with the overall business strategy, which includes the Paris alignment strategy. It is also useful for financial actors who seek to build their own alignment strategy and to understand the risk associated with this strategy.

In addition, when appreciating the counterparty's adaptive capacity in a context of deep uncertainty, financial actors may need to pay attention to the range of potential transitions considered in the counterparty's strategy. This requires

information on the counterparty's efforts to identify potential transition scenarios that represent key challenges and opportunities. It also calls for explanations from the company regarding the range of futures that the adaptive capacity seeks to prepare it for. Indeed, the company might choose to focus only on certain scenarios, while accepting the risk of losing in others. This choice should at least be made clear.

FIGURE 5: POTENTIAL INPUTS OF INTEREST TO APPRECIATE A COMPANY'S ADAPTIVE CAPACITY TO TRANSITION RISKS AND OPPORTUNITIES



Source: I4CE, 2022, Scenario analysis of transition risks in finance

@I4CE_

B. Taking account of the financial institution's adaptive capacity

The building blocks of the financial actor's challenges and capacity to handle those challenges

Financial actors may want to include in the analysis their own capacity to adapt to potential transition impacts arising from their activities. This was done, for example, in the context of the French supervisory pilot climate-related stress testing exercise, in order to take account of the strategic response of banks in the long-term[19][20].

Inclusion of the financial actor's adaptive capacity calls for exploring a range of considerations about the financial actors' own challenges and capacity to handle those challenges over time. This could include a discussion on the financial actor's potential risk management solutions, for example the relevance of changing loan collaterals or covenants, the relevance of holding a capital buffer, or the capacity to price risk, or the relevance of engaging with counterparties to influence their strategy as part of risk management.

The financial actor's strategy is also a key aspect of its adaptive capacity. The scenario analysis process may not take the financial actors' transition risk strategy as an external and pre-existing input. Instead, this process may be a place for discussing the financial actor's strategy with internal teams.

The need to foster dynamic connections between the financial actor's transition risk strategy, its broader business strategy and its counterparty's adaptive capacity

Financial actors may need to connect the dots between several issues in order to create a well-founded transition risk strategy that is consistent with the overall business strategy framework, and that can be operationalized in a concrete manner.

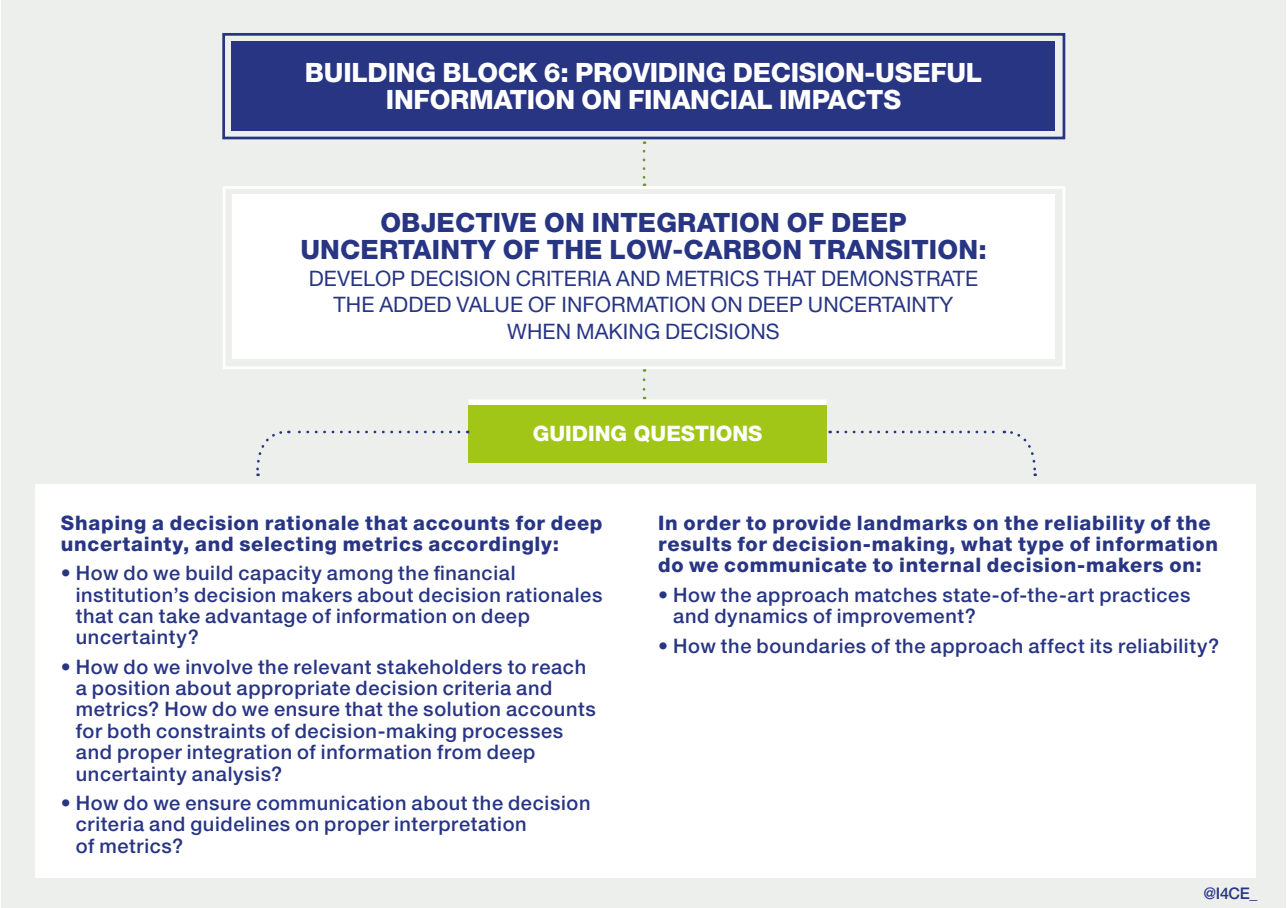
Financial actors may also need to connect the dots between their own transition risk management strategy – including risk taking – in the short and long term, and their broader strategic plans, including their potential transition plans. For example, as part of its plans to make a positive contribution to the low-carbon economic transition, a financial actor may want to provide funds to a counterparty so that it can implement its own transition plans. But at the same time it may require that the financial actor bears some financial risks (e.g. providing funds to a company to reshape its activities to move away from fossil fuel-dependance, but bearing the risk that this strategy is unsuccessful in certain key futures). The risk approach and the contribution approach may be contradictory – or mutually reinforcing in other instances, and at the very least it is essential that financial actors reflect on these interactions.

In this context, there is a greater need for financial actors to understand their counterparties' profiles in terms of transition financial risk and opportunity strategy, as well as interactions with the strategy to contribute to a low-carbon economic trajectory.

In the context of scenario analysis, financial actors may not only need to understand their counterparty's adaptive capacity. They may also consider that they can be active participants in their counterparty's adaptive capacity, potentially in connection with their goal of aligning with the Paris Agreement objectives. Financial actors could indeed engage a dialogue with their counterparties on the potential to provide more funds, and thus influence the financial feasibility of the counterparty's strategic options, including options that contribute to the low-carbon economy.

19. In the French ACPR pilot climate-related stress-testing exercise, the long-term strategic response was studied through a dynamic balance sheet assumption applied to long-term horizons.
20. As suggested in different sections of this report, financial actors may look at transition impacts in the short and long term.

6. Building block 6: Leveraging information on deep uncertainty to make decisions



6.1 WHY THIS BUILDING BLOCK OF SCENARIO ANALYSIS CAN HELP TO ADDRESS DEEP UNCERTAINTY

The previous building blocks of scenario analysis consisted in a significant effort to navigate potential economic and financial impacts in a context of deep uncertainty. This yields information on financial impacts in alternative futures, taking account of different transition pathways at the macro and sectoral levels, with net impacts also depending on the specific challenges and adaptive capacities of individual actors.

The next building block in the process is to ensure that decision-makers grasp the added value of this analysis for decision-making. This is the main motivation of the whole scenario analysis process.

Specific approaches may be necessary for leveraging information on uncertain transition impacts in decision-making processes. First, financial decision rationales and the supporting metrics are often not framed to integrate information on a range of deeply uncertain futures. At best, their treatment of uncertainty is implicit and limited.

Second, if uncertainty information is made more explicit and central in the decision metrics and rationales, then financial actors will need landmarks to appreciate the robustness of this information. This is necessary for them to build capacity to trust this information as a basis for their decisions.

6.2 SOME ELEMENTS OF AN OPTIMAL ANALYTICAL FRAMEWORK FROM A THEORETICAL POINT OF VIEW

Two principles are proposed to help financial actors make a better use of information on deep uncertainty in their transition risk management process. The first one is about defining decision rationale and metrics that are smart under deep uncertainty. The second one explains how to provide landmarks on the robustness of information in this context.

A. Developing a collective view on decision criteria and metrics that are appropriate in a context of deep uncertainty

A first element for an optimal framework is to explicitly address the question of uncertainty integration with internal deci-

sion-makers. They should build on an exploration of how deep uncertainty can be integrated into decisions and how this can be modelled in the supporting metrics, and then reach a shared position on this.

Decision-making frameworks in finance do not provide an obvious pathway for fully integrating deep uncertainty

Conventional decision frameworks in finance are not conducive to fully using information about financial impacts in a context of deep uncertainty.

For instance, an input in credit risk assessment is the counterparty's probability of default (PD) on the loan. The PD is usually calculated based mainly on historical data and forecasts. In the context of deep uncertainty, impacts from a range of key forward-looking transition scenarios should be considered. One of the potential methodological approaches developed in the market is producing a conditional PD for each alternative transition scenario. However, there is no specific guidance on how to make a decision based on this series of conditional PDs. It is important to at least question how this series could be used to inform the targeted decision process, and whether there are other actionable approaches that could be useful.

Another example is that financial decision frameworks are typically designed to make optimal decisions in a probabilistic environment, and their relevance could be questioned in a context of deep uncertainty. For instance, a discounted cash flow valuation model can take account of alternative scenarios through a series of alternative cash flows weighted by their respective scenario probability. This raises several concerns in a context of transition uncertainties.

First, the relevance of metrics aggregating a weighted average of alternative futures should be questioned. A potential solution approach could be to offer decision-makers a disaggregated series of scenario-conditioned valuations. However, this again raises the question of how to use these alternative estimates in decision-making.

Second, all key transition scenarios used for scenario analysis are plausible, but they cannot be ranked with an objective likelihood as historical data are not enough to make a forecast, and forward-looking models depend on their own subjective assumptions. Following Savage (1954), the usual treatment of uncertainty in finance would be to assign the scenarios with a subjective likelihood, as a means to remain within the probabilistic optimal decision framework. However, these factors would arise from a very subjective choice and would potentially have a strong influence on the expected level of financial impacts. Consequently, the motivation for assigning likelihoods or weights to scenarios should at least be discussed explicitly, along with other potential options.

Financial actors need to explore relevant decision rationales and metrics in a context of deep uncertainty

Based on the scenario analysis process, a wide range of metrics related to deep uncertainty could be envisaged to improve decisions. An essential preliminary step for the design of metrics is that financial actors explore and clarify the decision rationales they could use to properly integrate information on financial risks and opportunities under deep uncertainty, depending on their own context and objectives. Once this has been clarified, the appropriate metric should be designed accordingly to suit the decision rationale of the financial actor.

Several decision criteria can be used to divert attention from the perceived likelihood of scenarios, as summarized for example by Heal and Millner (2014). For instance, the "maximin" decision rule developed by Wald (1945) proposes that decisions should be based on the level of potential losses. Specifically, let us consider two portfolios and their respective losses in three scenarios. Portfolio 1 makes its worst loss in scenario 3, and portfolio 2 makes its worst loss in scenario 1. Portfolios 1's worst loss is larger than portfolio 2's worst loss. The maximin decision rule thus calls for choosing portfolio 2 over portfolio 1, because portfolio 2's largest loss (max) is the minimum (min) of all portfolios' respective largest losses in all scenarios. The decision is taken without paying attention to the perceived relative credibility of scenarios 1, 2, and 3. A financial actor could also seek to stay below a tolerated threshold of portfolio loss for all scenarios. Other decision criteria such as the "minimax regret" focus on the missed opportunities, rather than the worst cases.

A financial actor may also seek to select emerging winners in a given sector and consider diverse parameters of deep uncertainty to guide the decision. In this context, the adaptive capacity of counterparties would be a differentiating factor. Furthermore, the financial actor may focus on the higher gains and provide selection thresholds. It might also consider the domain of key scenarios where the counterparty makes higher gains than the others and build a selection rule and metrics based on this. It may also potentially consider the spectrum of futures where the counterparty is failing to adapt to the transition, with metrics on the magnitude of losses and on the range of cases where the counterparty is failing.

As part of its alignment strategy, a financial actor may also combine other types of uncertainty information with alignment information. For instance, it may look at each counterparty with a relevant alignment strategy, and the resilience of its strategy in a range of key scenarios. It may also focus on counterparties that are not aligned yet and seek to identify the financial feasibility of alignment strategies and what role it can play in this.

These are only illustrative examples and not recommendations on criteria and metrics to be used. Financial actors may need to engage in a systematic exploration of potential decision

criteria that would give a central role to the information on impacts in a range of uncertain yet plausible futures, taking account of the counterparty's adaptive capacities. Based on this exploration, they may decide on the relevant decision criteria and the different corresponding metrics. These could be various types of metrics: single indicators or matrices, scores or financial estimates, granularity on specific aspects of impacts or adaptive capacity depending on targeted use, etc.

The selection of appropriate decision criteria and metrics should be integrated into a collaborative process

Building on the exploration process described above, consultations with different stakeholders could be useful to select the relevant decision criteria and metrics in a context of deep uncertainty. This consultation process could involve, for example, the selected external service providers, internal ESG teams and decision-makers.

These different stakeholders could provide complementary inputs to define a decision-making process and metrics that are not only suited to integrating deep uncertainty, but also actionable in the institution's context. These choices should relate to the formulation of a well-founded transition risk strategy consistent with the broader business strategy. Supervisors could ask for justifications about these choices in the future.

This collective discussion could also help to take account of the heterogeneity of preferences among internal decision-makers. For example, some internal decision-makers – such as equity analysts – may have a certain degree of freedom in their decision function and in the type of information they use to support their decisions. To address this heterogeneity, the collective decision could at least produce some common guidelines on good practices and on the bad practices to avoid.

Further steps should be taken to ensure effective integration of the collective principles into decisions. Appropriate explanation and guidance should be communicated where appropriate to internal decision-makers, to ensure they have the same understanding of how to integrate transition uncertainty into decisions and how the supporting metrics can help. Financial institutions should also conduct monitoring of this effective integration and take follow-up measures where necessary.

B. Explaining the robustness of information exploring deep uncertainty

Establishing a clear integration process as detailed below is essential to make good use of information on deep uncertainty. Another key consideration is that financial actors need to build trust in this information to effectively use it in their decisions. Guidance on this point would be useful, as the "robustness of information on uncertainty" is not necessarily an obvious concept.

It is important to keep in mind that scenario analysis seeks to help make decisions that take account of key alternative futures without having clear prescient information. The principle of scenario analysis is to accept that some of the uncertainties about the future will not be resolved before the user is potentially in a strategic dead-end. It posits that the exploration of uncertain future dynamics may provide valuable information to better identify and address potential risks and opportunities.

In this context, a robust scenario analysis needs to meet several technical requirements that ensure the quality of the process. The present report provides some key elements to consider in each building block.

In practice, current approaches do not fulfill all the key elements presented in this report. Scenario analysis of transition issues in finance is a recent field and is being continuously improved. Progress is being made to better explore the deep uncertainty about impact channels and future transition scenarios, and to address data difficulties. Given these dynamics, as part of their robustness assessment, it is important for financial actors to ensure that they match state-of-the-art practices and dynamics. It is also important to understand how the boundaries of the approach affect its reliability.

However, further clarification may be needed on what can be considered a sufficiently robust approach to feed into decision-making in financial institutions. While service providers may provide some answers, other stakeholders can also play a role, such as supervisors in terms of setting the requirements.

III. RECOMMENDATIONS FOR EFFECTIVE IMPLEMENTATION OF GOOD PRINCIPLES

This report has outlined some of the good principles that financial institutions should ideally implement to integrate the deep uncertainty of the low-carbon transition into their strategy through scenario analysis.

So far, there has been limited evidence of financial actors implementing these good principles. Climate-related disclosure exercises have yielded patchy information on scenario analysis. The 2020 GARP survey also suggested that financial actors were making little effective use of scenario analysis for decision-making (GARP, 2020). More specifically, there is limited information on how financial actors consider using information on a range of potential future risks and opportunities in their decisions.

Financial actors have worked on scenario analysis with approaches developed by service providers. The review of these approaches is thus a good starting point to appreciate the dynamics of progress towards the implementation of the good principles proposed in this report.

This concluding section provides insights on the ongoing progress of service providers working with financial institutions, and how this may be complemented by the dynamics of a broader range of stakeholders.

1. Insights on service providers' progress: emerging best practices and points of attention

This section highlights the emergence of relevant best practices by service providers, as well as points of attention on areas where further efforts should be sustained. It is based on observations from the pool of services reviewed by I4CE, as detailed in the Methodology section of this report.

1.1 A PATCHWORK OF RELEVANT BEST PRACTICES HAS EMERGED AND NEEDS TO BE GENERALIZED

The dynamics for scenario analysis have gained momentum since the issuance of the TCFD recommendations in 2017. In recent years, multiple service providers and financial actors have been involved in the emergence of a patchwork of relevant best practices.

The methodologies reviewed by I4CE are already applicable to a wide range of financial portfolios, including diverse financial assets, sectors and countries. They target different levels of analysis with diverse approaches. When targeting analysis at a financial institution's balance sheet level, the service providers rely on macro and sectoral analysis. When targeting asset and portfolio level analysis, service providers typically rely on a bottom-up analysis of a range of companies (using databases that describe the range of companies) that can be combined with macro and sectoral analysis.

While the sum of these approaches may not yet be enough to fulfill all the targeted good principles, they demonstrate progress in this direction, as detailed below.

A. Relevant practices are observed on the main technical aspects of scenario analysis

Financial materiality approach

The methodologies reviewed by I4CE clarify that they adopt a financial risk assessment approach, typically by making connections between transition risk drivers and the profit drivers of counterparties, regardless of the nature of the output indicator (e.g. a score, a heatmap or an estimation of quantified financial impacts).

Extended time horizons

The time horizon of the analysis is also extended beyond the useful horizons of financial risk management to take account of transition dynamics in the coming decades, as described in transition scenarios.

Exploring transition issues

Some of the methodologies demonstrate efforts to explore specific issues at the activity level (meaning the sub-sectoral level).

Clarifying materiality assessment

A few methodologies enable financial actors to customize certain relevant materiality criteria, such as the selection of scenarios or sectoral weights in portfolios.

Using a range of state-of-the-art transition scenarios

Several methodologies also use a range of transition scenarios – including 1.5°C and 2°C scenarios – to assess financial impacts.

They also use state-of-the-art integrated assessment models to generate sectoral and macro variables. In addition, several methodologies strive to rapidly integrate the new sets of publicly available scenarios as they become available, including for instance NGFS scenarios.

Some service providers also seek to increase granularity at the country level, typically using NDCs as an input, with reprocessing when the objective is to make them comparable and compatible with limiting global warming to below 2°C.

Several methodologies include disorderly transition scenarios. Some of them are beginning to explore potential disruptions in the short term. For example, one methodology models a shift in market sentiment in the financial sector, leading to a sudden repricing of financial assets in the next five years.

Considering a range of impact channels for assessing impacts

Different types of impact propagation channels are considered for assessing impacts on counterparties. Several methodologies investigate the transition impacts on the EBITDA of non-financial companies. To do so, for instance, they can take account of shocks on the company's production costs, sometimes with assumptions on direct policy costs and cost pass-through from the upstream supply chain. They can also consider shocks on demand and the impact on the company's revenues from sales.

Taking steps to integrate adaptive capacities

The methodologies also strive to integrate the adaptive capacity of companies (e.g. capacity to invest; capacity to pay for carbon taxes; capacity to pass through costs to consumers) and their consequences on the market dynamics (e.g. secondary adjustment of demand as a consequence of a company's cost pass-through.) and the competitive environment (see section III.1.2 on technical challenges for data at company-level).

Demonstrating efforts to address data challenges

So far, some service providers have tried to address the limited availability of data on the specific challenges of the counterparties and on their adaptive capacity. They have done so through data mining, selection of proxies and modeling. Such approaches could be used to engage discussions with counterparties on their own scenario analysis.

For example, some methodologies aim to list potential solutions that counterparties may use (e.g. investments in new technologies) and seek to analyze the business case of these solutions through sectoral databases on the potential for emissions abatement and the cost of these solutions.

Some methodologies aim to characterize the counterparty's current resources that it could use to implement solutions. This has been done, for example, by analyzing the company-owned technological patents (using a patent database) as an indicator of the company's capacity to innovate and seize opportunities related to the sectoral low-carbon transition.

Some methodologies also make assumptions on the adaptation strategies of the company and its competitors. Some of them model the company's adaptation strategy compared to the whole market (e.g. beating the market). Others model how some companies in the same sector may exit the market as a result of transition impacts. Their market shares are reallocated to other companies, providing further adjustment to competitive dynamics and to transition impacts on the company under study.

B. Relevant practices on interaction with clients/users

A few service providers also make interaction with their clients/users a core aspect of the scenario analysis process. This may further increase the potential for strategic integration of deep uncertainty in the user's internal processes. For example, some service providers require the mobilization of the financial institution's teams to contribute to the analysis. In addition, beyond their flagship metric, some of them also provide customized outputs – such as a range of intermediate results – when the users consider that they are more suited to their internal analytical and decision processes.

C. The need to generalize the emerging best practices

These emerging best practices are not concentrated in one available service, but rather observed as a patchwork across the services that were reviewed in depth by I4CE. Moreover, these best practices could potentially be absent from the broader range of services identified in the pre-screening phase of the review process[21].

The generalization of these best practices may need to be stimulated by regulatory approaches, including with a focus on stimulating the demand. For example, financial actors still show limited demand for methodologies that require substantial mobilization of the financial institution's teams, even though this might help with the strategic integration of transition issues.

1.2 POINTS OF ATTENTION ON AREAS WHERE SUSTAINED EFFORTS ARE NEEDED

A. Limited transparency of modeling approaches

While the review of available services and scenarios highlights an increasing level of transparency on the methodological choices, further improvement in this field could still be achieved.

Transparency can still be improved on some key aspects of the scope of analysis, such as: the efforts made to explore potential transition risk dynamics (not only based on available scenarios); the criteria used to prioritize material risks; the selected risk drivers and the resulting impact channels that are effectively assessed.

More specifically, there is also a lack of transparency about whether the technical choices in scenarios and analytical approaches are considered satisfactory, or whether they result from technical limitations.

For example, it is not always clear whether the limited representation of specific risk drivers is justified after careful investigation of sectoral vulnerabilities, or whether it results from modeling issues.

There is also limited justification of the choice of parameters used to describe a risk driver or the counterparty's adaptive capacity. This could be driven by a modeling rationale, limited data availability, or constraints regarding compatibility with the broader datasets used for the analysis, etc.

More transparency is also needed on the motivations for using in-house scenarios more than publicly available scenarios. For example, this may be to make-up for the limitations of publicly available scenarios in terms of granularity and relevance of outputs. It may also arise from the willingness to use scenarios that reflect the financial actor's own belief about the most likely transition trajectory.

Improving transparency would help to build the capacity of financial actors to trust these analyses and thus use them when making their decisions, and it would also help to clarify the relevance of information disclosed based on these approaches. It could also help to better identify areas where further work is needed.

B. Technical challenges on scenarios

The NGFS has launched a collaboration between the community of scenario developers and financial supervisors. This has helped to clarify how some salient state-of-the-art modeling approaches could be mobilized to generate a range of scenarios needed for financial risk modeling. It appears that more work needs to be done in this area.

Concerning risk drivers, the nuance of specific climate policy tools and their consequences could be better developed than is the case with typical IAM shadow carbon prices. Shifts in consumer preference and behaviors in different economic sectors could also be addressed more explicitly.

The sectoral and country-specific representation of transition dynamics may also need to be explored further. Some pilot stress-testing exercises have begun to develop a sectoral downscaling of NGFS scenarios, as is the case with the French exercise. However, some transition dynamics at the sectoral level may need to be further explored and potentially incorporated into the modeling processes (I4CE, 2021b). More work also needs to be done on the representation of behaviors in the financial sector and of feedback loops in the financial sector and the real economy that may substantially amplify or mitigate transition risks.

More broadly, progress is needed on the modeling of the macro consequences of the transition – including GDP, and on the modeling of disorderly scenarios, including the realistic non-optimal behavioral responses of economic agents. For example, disorderly scenarios generated with optimization models typically include climate policy shocks that economic agents cannot foresee, but they react to the shock in an optimal fashion.

C. Technical challenges for counterparty data

Counterparty-level analysis – as well as analysis of other companies representing the competitive environment – suffers from limited data availability. For example, the distribution of company revenue by activity and country is necessary to measure the counterparty's exposure to transition risks (I4CE, 2020). This is also the case for data on the supply chain, where an important part of the risk could also be involved. Furthermore, little information on the company's strategic resilience is available from corporate disclosure (TCFD, 2020). However, it is a key driver of the company's adaptive capacity to transition risks. The lack of information on the exposure of portfolios to different activities is also an

21. See the methodology section at the beginning of this report.

impediment to the use of a sectoral classification of exposures for the materiality assessment.

Moreover, the analysis of the counterparty's adaptive capacity to transition issues may represent a heavy workload for large financial portfolios, as it may rely on multiple pieces of information, some of which are qualitative, for example on the counterparty's strategy. This raises questions about how to facilitate the collection of data and its processing. This may lead to reflection on how far it could be useful to further mobilize certain big data strategies, how other stakeholders could be involved in data processing, or how the data challenge could be simplified with appropriate proxies.

D. Challenges concerning the utility of information on deep uncertainty for financial actors' internal processes

Much of the demand for scenario analysis services from financial actors has arisen in the context of disclosure requirements. However, our exchanges did not confirm any further internal use for decision-making in financial institutions.

In particular, our interviews suggest that financial actors show little interest in information on financial impacts in a range of potential alternative futures. However, this is one of the focal points of the scenario analysis process and a potential source of added value for decisions. This may be due, for example, to a need for capacity building on this subject, or to the need to remove certain barriers and to further stimulate interest in order to integrate these issues more actively.

More broadly, it is also a complex task for service providers to help financial actors to connect the dots between scenario analysis, their transition financial risk strategies, Paris alignment strategies and broader business strategies. The relevant articulation between transition risk strategies and Paris alignment strategies probably requires discussions between a broader range of stakeholders, including financial supervisors. This could then encourage service providers to develop relevant updated approaches accordingly.

Figure 6 summarizes areas where work is needed to ensure strategic integration of deep uncertainty in financial institutions based on scenario analysis of transition risks and opportunities.

FIGURE 6: AREAS WHERE SUSTAINED EFFORTS ARE NEEDED TO ENSURE STRATEGIC INTEGRATION OF DEEP UNCERTAINTY

KEY ISSUES IDENTIFIED	WHAT IS NEEDED
> GOVERNANCE FOR STRATEGIC INTEGRATION OF TRANSITION RISKS IN THE FINANCIAL INSTITUTION	• Clarify the articulation of transition risk strategy with Paris alignment • Develop a rationale for making decisions on alternative complex futures and build relevant metrics accordingly • Build a consistent plan for mobilizing internal teams towards strategic integration of transition risks and deep uncertainty
> EXPLORATION OF TRANSITION ISSUES AND SCENARIOS	• Increase scope: all key sectors (including financial sector), feedback loops, macro consequences • Increase granularity: sector- and country-specific • Improve representation of disorderly transitions
> COUNTERPARTY ADAPTIVE CAPACITY	• Identify key counterparty data • Simplify data collection, processing and analysis
> TRANSPARENCY ON DIFFICULTIES	• Motivate key technical choices and clarify how satisfactory they are
> UPDATING THE APPROACH	• Sustain the uptake of best practices and contribution to their development

Source: I4CE, 2022, Scenario analysis of transition risks in finance

@I4CE_

2. Building on existing dynamics of multiple stakeholders to move forward

Further progress towards the implementation of the good principles for scenario analysis could involve a wider range of stakeholders, including financial actors, service providers, scenario developers, counterparties, financial regulators and supervisors, public agencies specializing in environmental issues, etc.

Some of these stakeholders are already engaged in dynamics that may be relevant for harvesting the strategic potential of scenario analysis. In particular, financial regulators and supervisors have played a key role so far in mobilizing financial actors and their stakeholders on transition risk. They need to keep expanding their efforts to drive consistent integration of transition risks and uncertainties in the financial sector.

2.1 SUPERVISORS AND REGULATORS COULD STIMULATE THE UPTAKE OF EMERGING BEST PRACTICES AND FOSTER FURTHER TECHNICAL EFFORTS

A. Disclosure approach

Financial regulators should update disclosure requirements periodically, with minimum technical requirements as detailed by I4CE and ILB (2021). These can be formulated to require the uptake of emerging best practices in scenario analysis, to clarify when analytical choices arise from technical difficulties, and to stimulate further efforts. Such an approach was implemented in 2021 in France through the Implementing Decree of Article 29 of the Energy and Climate Act. It goes beyond the usual level of detail in an implementing decree.

This approach could be replicated in European disclosure frameworks. It could complement the existing RTS of the SFDR – the European regulatory sustainability-related disclosure framework for financial market participants and financial advisers[22][23]. It could also be applied to the sequential approach pursued by the EBA ,with the final draft ITS developed in the context of Pillar 3 ESG disclosure requirements under Article 449a of the CRR for large credit institutions that have issued securities that are admitted to trading on a regulated market in any EU Member State[24].

This type of approach should also be generalized to other countries.

B. Review of internal practices

This stimulation of sustained improvements in scenario analysis of transition issues could also be integrated into the supervision of financial institutions' internal practices to include transition risk in their governance, strategy and risk management.

For instance, in 2020 the ECB published a guide including supervisory expectations about scenario analysis for strategy setting and risk management, as well as disclosure expectations (ECB, 2020). The ECB could update its guidance documents periodically with minimum requirements and measure progress in their implementation in further periodic stocktaking exercises.

In order to impose strong, legally binding requirements on the framing of scenario analysis for internal purposes, the EBA could also integrate minimum technical requirements under Pillar 2 of bank prudential frameworks. Pilot climate-related stress-testing exercises carried out as part of Pillar 2 have also played a major role in mobilizing financial institutions' internal teams in a process that seeks to analyze impacts in a range of potential futures. This has helped to identify difficulties (including gaps in data and methodologies) and to move forward. This has been the case, for example, with the exercises conducted in France by ACPR involving the participation of credit institutions and insurance companies. The replication of these exercises could help to address further challenges.

2.2 PUBLIC AUTHORITIES MAY CLARIFY THE ARTICULATION OF THE FINANCIAL ACTORS' TRANSITION RISK STRATEGY AND THEIR PARIS ALIGNMENT STRATEGY

The overall integration of scenario analysis in decision-making may benefit from a clarification of how transition risk management and Paris alignment strategy should articulate with each other. Such clarification may require intervention of supervisors for several reasons.

22. Implementing Decree of Article 29 of the Energy and Climate Act. Full reference: Decree no. 2021-663 of 27 May 2021 implementing Article L.533-22-1 of the Monetary and Financial Code. NOR: ECOT2112559D. https://www.tresor.economie.gouv.fr/Articles/80af1116-2fcd-47d0-ad1d-ea24352e6295/files/273f9026-bbc4-4fc2-ba60-f86f6fe16c1f

23. SFDR – Disclosure Regulation. Full reference: Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector (Text with EEA relevance). OJ L 317, 9.12.2019, p. 1–16. https://eur-lex.europa.eu/eli/reg/2019/2088/oj

24. EBA's final draft ITS on Pillar 3 disclosures of ESG risks under the Capital Requirements Regulation. Full reference: Final report – Final draft implementing technical standards on prudential disclosures on ESG risks in accordance with Article 449a CRR. EBA/ITS/2022/01. https://www.eba.europa.eu/eba-publishes-binding-standards-pillar-3-disclosures-esg-risks

A. Why the perspective of regulators and supervisors is needed

NGFS scenarios suggest, for example, that an early and orderly transition induces less climate and transition risk exposure for the whole economy (NGFS, 2021). In contrast, delaying the transition would lead to a long-term risk of aggravated impacts from physical climate change for the whole system, and potentially some late, disorderly and sudden transition efforts leading to additional financial risk. The early and orderly contribution of the financial sector to a low-carbon transition would therefore make sense from a long-term and economy-wide risk perspective.

However, financial actors' approaches to transition risk have so far failed to mobilize them in contributing to the transition of the real economy. Many financial actors focus their management on the short-term risks to their portfolio. They also seem to have persistently considered that a lack of immediate effort towards the transition has not exposed them to a high level of financial risk.

Regulators and supervisors may therefore need to reintegrate the long-term economy-wide risk perspective into both the financial risk strategies and the Paris alignment strategies of financial actors, while recognizing differences in institutions' risk profiles.

Some explanation of this issue is introduced, for example, in the ECB guide on climate-related and environmental risks, as well as in the EBA report on ESG risks (ECB, 2020; EBA, 2021)[25].

Proposals to introduce a transition plan requirement in prudential supervisory reviews of financial actors' internal practices may be a good way to foster clarification in legally-binding frameworks of how financial actors should articulate financial transition risk strategies with Paris alignment strategies (I4CE, 2022).

B. Building capacity among supervisors and regulators

To provide clarification, the financial regulators and supervisors should sustain efforts to build their capacity on environmental and transition issues. While relevant internal human resources are key, regulators and supervisors should also identify and capitalize on relevant expertise concerning these issues to avoid duplicating efforts. Among potential approaches to achieve this, climate-related stress-testing exercises have proved useful for supervisors to collaborate with scenario developers. Collaborations could also be explored with competent public environmental agencies, at both the national and the European level.

2.3 REGULATORS AND OTHER STAKEHOLDERS CAN HELP WITH UPTAKE OF SCENARIO ANALYSIS BY THE TEAMS IN FINANCIAL INSTITUTIONS

A. Regulating and supervising the governance of financial institutions on scenario analysis

Setting up appropriate governance is indeed a key prerequisite for strategic integration of transition issues and should be done very quickly, hence the need to stimulate and monitor progress on this in the short term.

Financial actors should disclose more information on the integration of scenario analysis in decision-making. This may require indicators about proportionate dedicated resources, and descriptions of how relevant teams are involved (e.g. ESG and risk divisions) in the scenario analysis process, how they interact with decision-makers, and how they combine efforts deployed for climate-related stress-testing exercises. Disclosure requirements are making progress through the French 29 LEC implementing decree. At the European level, they are expected to make progress through the CSRD standards currently under development.

In addition, when carrying out reviews of future disclosure exercises, the observers and supervisors may need to put more emphasis on monitoring how financial actors comply with these governance requirements, instead of a specific focus on the evolution of policy dynamics and portfolio indicators.

The governance of scenario analysis for strategy setting and risk management should also be part of the prudential supervisory review of financial actors' internal practices.

B. Co-designing approaches

The co-design of approaches between climate experts and financial actors has proven useful. As reported in the ClimINVEST project (2021) on physical climate risk, it helps to build mutual understanding of the capacities and needs of financial actors and external experts, including service providers. It also helps to mobilize internal teams in financial institutions and to make progress towards designing an approach that can effectively inform decision-making. Other initiatives such as the UNEP-FI working groups are also important in pooling

25. For example, page 23 of ECB (2020): "To achieve a holistic approach to risk, while considering the institution's long-term financial interest, the management body is advised to explicitly consider the institution's response to the objectives set out under international agreements such as the Paris Agreement (2015), […]".

efforts. These approaches are all the more useful when they provide publicly available resources for all actors.

Pilot climate-related stress-testing exercises organized by supervisors are also a powerful tool to start building capacity in the internal teams of financial institutions. This is one more reason to replicate such exercises on a regular basis.

2.4 COLLABORATIONS TO MAKE PROGRESS ON SCENARIOS THAT ARE SUITED TO STRATEGIC RISK ASSESSMENT

Concerted work to build sectoral transition plans at the national level can help to explore potential sectoral dynamics and to create a shared view of potential transition pathways at the national level. An example of such work has been coordinated in France by ADEME – the French public agency for the ecological transition – in the context of the Finance ClimAct project[26]. This type of exercise should be replicated in other countries. The findings of these plans could then be incorporated into scenario analysis approaches to highlight financial impacts of the transition at the sectoral and country levels.

Research is also moving forward on several topics, for example on the representation of the financial sector dynamics and feedback effects on the real economy, or on the representation of disorderly transitions and on the macro consequences of the transition. Their dissemination in fora such as the NGFS may foster their appropriation by supervisors and financial institutions.

2.5 APPROACHES TO ADDRESS THE DATA CHALLENGE FOR ADAPTIVE CAPACITY OF COUNTERPARTIES

Where feasible, engagement of financial institutions with their counterparties may help to achieve a more granular picture of transition risks and opportunities, and of how the financial institution can contribute.

Automation processes may help with data collection, and harmonization may facilitate data use. Both harmonization and automated processes are targeted at the European level, in the context of the Corporate Sustainability Reporting Directive (CSRD) applying to non-financial and financial companies. This includes a disclosure standardization process by EFRAG, with a view to building a European Single Access Point (ESAP) of harmonized data. Big data approaches may also help.

Other financial service providers such as rating agencies can also play an important role in collecting data and analyzing the risks and opportunities of individual counterparties, to provide financial actors with information that can be used easily. However, rating agencies and other service providers need to ensure that their approaches are sufficiently transparent, and appropriate for the decision-making processes of financial institutions. Work on the transparency of rating agencies is targeted by the European Commission's renewed strategy for financing the transition to a sustainable economy[27].

Research is also needed on how the technical choices, including the level of data granularity, affect the results. Research could also promote pioneer approaches that can be extended to more companies/sectors as data becomes available. More broadly, research may also develop further insights on how to build smart decision criteria in a context of deep uncertainty, building on existing work as proposed by I4CE (2019a).

26. For more information on sectoral transition plans in the context of the Finance ClimAct project, see: https://finance-climact.eu/news/sectoral-transition-plans/ For more information on sectoral transition plans in the context of the Finance ClimAct project, see: https://finance-climact.eu/news/sectoral-transition-plans/

27. EU Strategy for financing the transition to a sustainable economy. Full reference: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Strategy for Financing the Transition to a Sustainable Economy. COM/2021/390 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0390

CONCLUDING REMARKS

So far, the discussions on scenario analysis in the context of disclosure have largely focused on the metrics resulting from scenario analysis that would be relevant for market participants to appreciate and compare the level of financial actors' transition risk exposure.

However, the TCFD has primarily recommended the use of scenario analysis for strategic purposes. Indeed, scenario analysis has the potential to help financial institutions to build a process for the strategic integration of transition risks and opportunities that fully recognizes the deep uncertainty of the low-carbon transition.

To harvest this strategic potential, more attention needs to be paid to the mobilization of internal teams in the process. It is also necessary to clarify the articulation of transition risk management and other aspects of the strategy. Financial regulators and supervisors can play an important role in ensuring that risk management practices are balanced with the need to finance an early and smooth transition of the real economy towards a low-carbon system. Different stakeholders also have a role to play in addressing the remaining technical challenges. The "guiding questions" presented in this report can help different stakeholders to identify some of the good principles that financial actors should seek to implement in order to make progress on organizational and technical aspects of scenario analysis.

Moving forward, financial actors will also need to combine the analysis of transition issues with broader environmental issues, including physical climate and biodiversity issues already flagged as a priority by French disclosure requirements. Financial regulators and supervisors are more broadly aiming to steer progress on the integration of a wider range of sustainability and ESG issues. This will raise questions on how to analyze this increasing number of complex issues and to find ways to provide information and to take action on all of them.

References

- 2dii. 2017. Changing colors – ***Adaptive capacity of companies in the context of a transition to a low carbon economy. Tragedy of the horizon program / ET Risk project.*** https://2degrees-investing.org/resource/changing-colors-adaptive-capacity-of-companies-in-the-context-of-the-transition-to-a-low-carbon-economy/
- Banque de France. 2022. ***"Too Little, Too Late":*** Impact of a Disorderly Climate Transition. 8 February 2022. https://blocnotesdeleco.banque-france.fr/en/blog-entry/too-little-too-late-impact-disorderly-climate-transition
- Battiston, S., Mandel, A., Monasterolo, I. 2019. ***CLIMAFIN Handbook: Pricing Forward-Looking Climate Risks Under Uncertainty*** (October 28, 2019). https://ssrn.com/abstract=3476586 or http://dx.doi.org/10.2139/ssrn.3476586
- Battiston, S., Monasterolo, I. Riahi, K., van Ruijven, B. J. 2021. ***Accounting for finance is key for climate mitigation pathways.*** Science. 20 May 2021. DOI: 10.1126/science.abf3877
- BCBS. 2021. ***Consultative Document - Principles for the effective management and supervision of climate-related financial risks.*** Issued for comment by 16 February 2022. November 2021. Basel Committee on Banking Supervision. https://www.bis.org/bcbs/publ/d530.pdf
- Bingler, J. A., Colesanti Senni, C., Monnin, P. 2021. ***Climate Transition Risk Metrics: Understanding Convergence and Divergence across Firms and Providers.*** (September 14, 2021). Available at SSRN: https://ssrn.com/abstract=3923330 or http://dx.doi.org/10.2139/ssrn.3923330
- Bingler, J. A., Colesanti Senni, C. 2020. ***Taming the Green Swan: How to improve climate-related financial risk assessments. CER-ETH – Center of Economic Research at ETH Zurich. Zürich.*** Economics Working Paper Series, 20/340. https://www.research-collection.ethz.ch/handle/20.500.11850/428321
- Carbon Tracker. 2019. ***Breaking the Habit – Methodology.*** https://carbontransfer.wpengine.com/wp-content/uploads/2019/09/Breaking-the-Habit-Methodology-Final-1.pdf
- Carbon Tracker. 2021. ***Adapt to survive: Why oil companies must plan for net zero and avoid stranded assets.*** https://carbontracker.org/reports/adapt-to-survive/
- Carbon Tracker. 2014. ***Carbon Supply Cost Curves: Evaluating Financial Risk to Oil Capital Expenditures.*** https://carbontracker.org/reports/carbon-supply-cost-curves-evaluating-financial-risk-to-oil-capital-expenditures/
- CFRF. 2020. ***Climate Financial Risk Forum Guide 2020 - Scenario analysis chapter.*** London, UK: Climate Financial Risk Forum. https://www.fca.org.uk/publication/corporate/climate-financial-risk-forum-guide-2020-scenario-analysis-chapter.pdf
- Climate Transparency Hub. 2021. Rapport annuel CTH 2020 : Étude sur l'état des pratiques – informations et données – de reporting climat (2019). https://climate-transparency-hub.ademe.fr/wp-content/uploads/2021/01/rapport-annuel-cth-2020.pdf
- ClimINVEST. 2021. ***Addressing challenges of physical climate risk analysis in financial institutions.*** https://www.i4ce.org/download/addressing-challenges-of-physical-climate-risk-analysis-in-financial-institutions/
- Deloitte. 2019. ***ClimWise – Assessment of climate risk for credit portfolios.*** https://www2.deloitte.com/content/dam/Deloitte/fr/Documents/sustainability-services/deloitte_brochure-climwise-en.pdf
- Deloitte.2020. ***The Predictive Power of Stress Tests to Tackle Climate Change.*** https://www2.deloitte.com/content/dam/Deloitte/fr/Documents/sustainability-services/deloitte_climate-risk-assessment.pdf
- DNB. 2018. ***An energy transition risk stress test for the financial system of the Netherlands***. https://www.dnb.nl/media/pdnpdalc/201810_nr-_7_-2018-_an_energy_transition_risk_stress_test_for_the_financial_system_of_the_netherlands.pdf
- Dunz, N, Naqvi, A, Monasterolo, I. 2021. ***Climate Sentiments, Transition Risk, and Financial Stability in a Stock-Flow Consistent Model.*** Journal of Financial Stability DOI: 10.1016/j.jfs.2021.100872 [pure.iiasa.ac.at/17153]
- EBA. 2021. ***EBA report on management and supervision of ESG risks for credit institutions and investment firms –*** EBA/REP/2021/18. https://www.eba.europa.eu/sites/default/documents/files/document_library/Publications/Reports/2021/1015656/EBA%20Report%20on%20ESG%20risks%20management%20and%20supervision.pdf
- ECB. 2020. ***Guide on climate-related and environmental risks – Supervisory expectations relating to risk management and disclosure. European Central Bank.*** https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.202011finalguideonclimate-relatedandenvironmentalrisks~58213f6564.en.pdf;
- ECB. 2021. ***The state of climate and environmental risk management in the banking sector - Report on the supervisory review of banks' approaches to manage climate and environmental risks. European Central Bank.*** https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.202111guideonclimate-relatedandenvironmentalrisks~4b25454055.en.pdf
- ECB. 2022. ***Supervisory assessment of institutions' climate-related and environmental risks disclosures – ECB report on banks' progress towards transparent disclosure of their climate-related and environmental risk profiles.*** https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.ECB_Report_on_climate_and_environmental_disclosures_202203~4ae33f2a70.en.pdf

- EFRAG. 2022.***[Draft] European Sustainability Reporting Standard E1 Climate change.*** Working paper, January 2022. http://www.efrag.org/Assets/Download?assetUrl=/sites/webpublishing/SiteAssets/Appendix%202.5%20-%20WP%20on%20draft%20ESRS%20E1.pdf
- ET Risk project. 2017. ***The transition risk-o-meter: Reference scenarios for financial analysis.*** http://et-risk.eu/the-transition-risk-o-meter/
- GARP Risk Institute. 2020. ***Second annual global survey of climate risk management at financial firms.*** https://f.hubspotusercontent20.net/hubfs/20013225/Website/GRI/PDF/a1Z1W000005VBtwUAG.pdf
- Heal, G., Millner, A. 2014. ***Uncertainty and Decision Making in Climate Change Economics.*** Review of Environmental Economics and Policy, volume 8, issue 1, 2014, pp. 120–137. doi:10.1093/reep/ret023
- IEA. 2021. ***Net Zero by 2050. A Roadmap for the Global Energy Sector. International Energy Agency.*** https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf
- IIASA. 2021. ***Press release*** (https://previous.iiasa.ac.at/web/home/about/210517-financial-stability-and-climate-change.html)
- IIGCC. 2019. ***Navigating climate scenario analysis – a guide for institutional investors.*** https://www.iigcc.org/resource/navigating-climate-scenario-analysis-a-guide-for-institutional-investors/
- ILB and I4CE. 2020. ***The alignment cookbook: a technical review of methodologies assessing a portfolio'salignment with low-carbon trajectories or temperature goal.*** Institut LouisBachelier. https://gsf.institutlouisbachelier.org/the-alignment-cookbook-a-technical-review-of-methodologies-assessing-a-portfolios-alignment-with-low-carbon-trajectories-or-temperature-goal/
- IMF. 2019. ***Fiscal Monitor: How to Mitigate Climate Change.*** Washington, October. https://www.imf.org/en/Publications/FM/Issues/2019/09/12/fiscal-monitor-october-2019
- IMF. 2021. ***Are Climate Change Policies Politically Costly ?.*** IMF Working Paper. WP/21/156. Asia and Pacific Department. Prepared by Davide Furceri, Michael Ganslmeier and Jonathan D. Ostry. Authorized for distribution by Jonathan D. Ostry. June 2021. https://www.imf.org/-/media/Files/Publications/WP/2021/English/wpiea2021156-print-pdf.ashx
- IPCC. 2014. ***Summary for policymakers. In: Climate Change 2014: Impacts,Adaptation, and Vulnerability.*** Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32. https://www.ipcc.ch/site/assets/uploads/2018/02/ar5_wgII_spm_en.pdf
- I4CE. 2019a. ***Towards an alternative approach in finance to climate risks: taking uncertainties fully into account.*** https://www.i4ce.org/download/for-another-approach-to-climate-risk-in-finance-taking-uncertainties-fully-into-account/
- I4CE. 2019b. ***Understanding transition scenarios – Eight steps for reading and interpreting these scenarios.*** https://www.i4ce.org/download/understanding-transition-scenarios-eight-steps-for-reading-and-november-2019-interpreting-these-scenarios/
- I4CE. 2020. ***Scenario analysis of the issues of the low-carbon transition*** https://www.i4ce.org/download/scenario-analysis-of-the-issues-of-the-low-carbon-transition/
- I4CE and ILB. 2021. ***Taking climate-related disclosure to the next level – Minimum requirements for financial institutions.*** https://www.i4ce.org/download/taking-climate-related-disclosure-to-the-next-level-minimum-requirements-for-financial-institutions/
- I4CE. 2021b. ***The integration of transition risk drivers at a sectoral level - New perspectives for climate stress tests and other climate risk management tools.*** https://www.i4ce.org/download/climate-stress-tests-the-integration-of-transition-risk-drivers-at-a-sectoral-level/
- I4CE. 2022. ***Include mandatory banking transition plans within Pillar 2.*** https://www.i4ce.org/download/include-mandatory-banking-transition-plans-within-pillar-2/ vIIGCC. 2019. Navigating climate scenario analysis – a guide for institutional investors. https://www.iigcc.org/resource/navigating-climate-scenario-analysis-a-guide-for-institutional-investors/
- Knight, Frank. 1921. ***Risk, Uncertainty and Profit. Risk, Uncertainty and Profit, Houghton Mifflin Company,*** Boston, MA. https://doi.org/10.1017/CBO9780511817410.005
- Marchau, V. A. W. J., Walker W. E., Bloemen, P. J. T. M., Popper, S. W. 2019. ***Decision Making under Deep Uncertainty - From Theory to Practice. Springer International Publishing.*** https://doi.org/10.1007/978-3-030-05252-2
- Monnin, P. 2018. ***Integrating Climate Risks into Credit Risk Assessment - Current Methodologies and the Case of Central Banks Corporate Bond Purchases.*** Council on Economic Policies, Discussion Note 2018/4. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3350918
- NGFS. 2020a. ***Case Studies of Environmental Risk Analysis Methodologies. NGFS Occasional Paper.*** https://www.ngfs.net/node/312018

- NGFS. 2020b. ***Guide to climate scenario analysis for central banks and supervisors.*** Network for Greening the Financial System. Technical document. https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_scenario_analysis_final.pdf
- NGFS. 2021. ***NGFS Climate Scenarios for central banks and supervisors***. https://www.ngfs.net/sites/default/files/media/2021/08/27/ngfs_climate_scenarios_phase2_june2021.pdf
- TCFD. 2017. ***Recommendations of the Task Force on Climate-related Financial Disclosures.*** https://assets.bbhub.io/company/sites/60/2020/10/FINAL- 2017-TCFD-Report-11052018.pdf
- TCFD. 2021. ***2021 Status Report.*** https://www.fsb.org/wp-content/uploads/P141021-1.pdf
- Trucost. 2019. ***Trucost Carbon Earnings at Risk - Forward-looking Estimates of Financial Risk.*** https://www.spglobal.com/en/Perspectives/IIF-2019/Trucost-Carbon-Earnings-at-Risk.pdf
- UNEP FI and Oliver Wyman. 2018. ***Extending our horizons: assessing credit risk and opportunity in a changing climate. Part I: Transition-related risks and opportunities.*** https://www.unepfi.org/publications/banking-publications/extending-our-horizons/
- UNEP FI, Carbon Delta and Vivid Economics. 2019. ***Changing course: a comprehensive investor guide to scenario-based methods for climate risk assessment, in response to the TCFD.*** https://www.unepfi.org/publications/investment-publications/changing-course-a-comprehensive-investor-guide-to-scenario-based-methods-for-climate-risk-assessment-in-response-to-the-tcfd/
- UNEP FI. 2021. ***The Climate Risk Landscape: Mapping Climate-related Financial Risk Assessment Methodologies.*** https://www.unepfi.org/publications/banking-publications/the-climate-risk-landscape/
- Urgentem. 2022. ***Urgentem Element6 Climate Analytics platform.*** https://www.urgentem.net/_files/ugd/1b942e_5e7864d0157b45348e70b34e8d641747.pdf
- Wald, A. 1945. ***Statistical decision functions which minimize the maximum risk.*** The Annals of Mathematics 46 (2): 265–80.

ABOUT THE FINANCE CLIMACT PROJECT

The Finance ClimAct project contributes to the implementation of France's National Low-Carbon Strategy and the European Union's Sustainable Finance Action Plan. It aims to develop new tools, methods and knowledge enabling (1) retail investors to integrate environmental targets into their investment choices, and (2) financial institutions and their supervisors to integrate climate issues into their decision-making processes and to align financial flows with energy/climate objectives.

The consortium, coordinated by ADEME, also includes the French Ministry for the Ecological Transition, the Autorité des Marchés Financiers (AMF), the Autorité de Contrôle Prudentiel et de Résolution (ACPR), the 2° Investing Initiative, the Institute for Climate Economics, Finance for Tomorrow and GreenFlex.

Finance ClimAct is an unprecedented programme with a total budget of €18 million and funding of €10 million from the European Commission.

Duration: 2019-2024

I4CE INSTITUTE FOR CLIMATE ECONOMICS
Une initiative de la Caisse des Dépôts et de l'Agence Française de Développement

www.i4ce.org

Finance ClimAct

With the contribution of the European Union LIFE programme

INSTITUTE FOR CLIMATE ECONOMICS
30 rue de Fleurus - 75006 Paris

www.i4ce.org
Contact : contact@i4ce.org

Suivez-nous sur

Création-réalisation : Laëtitia Colas