

CARBON MANAGEMENT AND PRICING: RISKS AND OPPORTUNITIES FOR FINANCIAL INSTITUTIONS

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April 2018

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ACKNOWLEDGEMENTS

FEBRABAN's Social Responsibility
and Sustainability Committee

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BNP Paribas, Braskem, CPFL Energia, Fibria,
International Finance Corporation and Vale.

Contents

List of figures	4
List of tables	4
List of boxes	4
Presentation	5
1. Introduction and objectives	7
2. Carbon risk management	10
Climate-related risks and opportunities and financial impacts.....	11
Climate-related Financial Disclosures.....	15
3. Carbon pricing outlook	18
Concept, scope and limitations.....	19
Mandatory pricing: taxation and emissions trading system.....	22
Voluntary pricing: internal carbon price.....	26
Carbon pricing in Brazil.....	29
4. Carbon pricing and financial institutions	32
5. Methodological approaches	37
Study limitations.....	40
6. Results and analyses	41
Financial sector practices.....	41
Practices of the productive sector.....	43
Outlook of Brazilian companies.....	43
Case analyses.....	49
7. Relevant sector-related questions: illustrative examples	56
8. Recommendations to financial institutions	62
9. Conclusions	65
10. References	67
Appendixes	69

List of figures

Figure 1. Climate-related risks and opportunities and financial impacts	13
Figure 2. Illustration of basic concepts.....	14
Figure 3. Recommendations on disclosure categories proposed by the Task Force on Climate-related Financial Disclosures	16
Figure 4. Different carbon pricing approaches	21
Figure 5. Steps to establish an internal carbon price	28

List of tables

Table 1. Associated groups and industries with the highest exposure to climate-related risks.....	17
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List of boxes

Box 1. Risks related to climate: concepts	11
Box 2. TCFD additional recommendations to asset managers	35
Box 3. Highlights of 2016 CDP Climate Change responses	48
Box 4. Strategies and actions of the interviewed organizations with respect to the “governance” pillar	49
Box 5. Strategies and actions of the interviewed organizations with respect to the “strategy” pillar	51
Box 6. Strategies and actions of the interviewed organizations with respect to the “risk management” pillar.....	52
Box 7. Strategies and actions of the interviewed organizations with respect to the “metrics and targets” pillar	53

Presentation

The Brazilian Federation of Banks (FEBRABAN) and the Center for Sustainability Studies at the Getulio Vargas Foundation (FGVces) have established a partnership that is now in its fourth cycle of activities to analyze the possible ways to leverage the transition towards a Green Economy in Brazil by using resources intermediated by the National Financial System (NFS).

Throughout this fourth year, four studies were conducted, three of which are a sequel to the studies started in the previous year. The first one analyzes the economic-financial feasibility of adopting photovoltaic systems in Brazil to determine the scalability of financing such projects. The second study intends to evaluate the economic-financial feasibility of financing models for the recomposition of Legal Reserve Areas (LRA) where economic exploration is possible. The third study aims to analyze the implications and risks for financial institutions of deforestation on the livestock, soybean, wood products and palm oil supply chains. Finally, the last study, which starts a new line of research, addresses the climate risk management by banks and companies, with emphasis on risks and opportunities related to carbon pricing.

This report presents the last study and seeks to identify trends related to high carbon emissions and concentrations, including risks and opportunities derived from pricing; map the practices of carbon risk management by companies of selected economy sectors; and identify relevant sector-related topics to be considered by financial institutions upon managing the carbon risk in their analyses of socio-environmental risks. The research was carried out through: i) bibliographic review, in particular with respect to risks related to climate change and its impacts and carbon pricing (mandatory and voluntary); ii) documentary analysis of Brazilian companies participating in the CDP Climate Change, a program in which public companies report information related to climate change and its connection with business strategy in the CDP public platform; iii) interviews with international banks involved with carbon risk management topic; iv) interviews with companies operating in Brazil, which adopt carbon risk management practices; v) discussions with FEBRABAN members; and vi) internal discussions of FGVces team.

The study is organized into ten chapters. Chapter 1 indicates the context in which the work is inserted and its objectives. Chapter 2 shows the current scenario of carbon risk management, by addressing the typology of climatic risks, while Chapter 3 presents the scenario of carbon pricing by addressing the concept, its approaches and the status of mandatory and voluntary pricing at international level and in Brazil. Chapter 4 discusses the relation between the financial sector and carbon pricing by exposing the initiatives involving this sector. Chapter 5 describes the methodological study approach, which is composed of bibliographic and documentary analysis and interviews. Chapter 6 provides the study results and its analyses by describing carbon risk management practices in the productive sector and surveyed banks. Chapter 7 brings examples of sector-related questions that are relevant to carbon risk management and should be considered by financial institutions in their socio-environmental risk analyses. Chapter 8 lists the general recommendations to financial institutions, while Chapter 9 lists the conclusions. Lastly, Chapter 10 provides the bibliographic references.

1. Introduction and objectives

Climate change has economic, social and financial implications for the world economy. It is estimated that, as a result of climate change,¹ assets amounting to US\$ 2.5 trillion may be at risk, accounting for 1.8% of the world economy.²

By recognizing that a transition to a low-carbon economy will have implications for the financial system worldwide, the G20 Ministers of Finance and Central Bank leaders requested the Financial Stability Board to make an analysis of how the financial sector may consider, in their operations, aspects related to climate. In this context, the Task Force on Climate-related Financial Disclosures – TCFD was created with the objective of developing recommendations on more effective corporate disclosures of companies' practices and management to face climate change. The TCFD objective is to promote decisions on investments, credit granting and insurance contracting supported by better information on climate impacts. Additionally, this initiative intends to understand and clarify the concentration of carbon-related assets in financial sector and its exposure to climate-related risks.

Climate change and a transition to a low-carbon economy introduce new risks and opportunities for financial institutions and companies. If, on one side, the productive sector is directly exposed to risks related to climate change, banks will be affected especially in an indirect way as the economic activity is generally affected. Economy prices may be changed as long as the costs of environmental externalities, including the emission of greenhouse gases, are incorporated to goods and services, thus changing the competitiveness and the economic feasibility of some economic activities.

¹ The study considers a global warming of 2.5oC until 2100.

² (Dietz, Bowen, Dixon, & Gradwell, 2016)

Possible consequences in the long term include unsuccessful loans, reduction of assets prices, additional regulatory costs and increased reputational risk. In addition, non-management of climate risk by financial institutions may lead to a high concentration of assets under risk in credit and investment portfolios, thus creating a systemic risk to financial stability.³

In this sense, it is essential that carbon risk integrates the risk management process of financial institutions. According to the Brazilian Central Bank (through Resolution no. 4,557 of 2017⁴), risk management is an integrated process that allows the identification, measurement, evaluation, monitoring, reporting, control and mitigation of adverse effects from interactions among risks to which the institutions are exposed. In Resolution 4,557, the Central Bank considers that the following risks should be managed: credit, market, interest rate variations, operational, liquidity, socio-environmental and other relevant risks according to criteria established by the institution. Carbon risk is directly linked to socio-environmental risk, but it can also impact the other categories of risks to which the financial institutions are exposed. Similarly, in the case of investors, carbon risk may adversely impact the economic value of invested companies.

Climate policies intended to reduce the emissions of greenhouse gases (GHG) may affect, whether positively or negatively, revenues and costs of several productive sectors by generating indirect effects on financial players holding securities of companies of such sectors. Internationally, about 100 Signatories of the Paris Agreement, which account for 58% of global GHG emissions, are considering the implementation of carbon pricing instruments to support the achievement of their Nationally Determined Contributions⁵ (NDC).

³ (PWC, 2016)

⁴ (Banco Central do Brasil, 2017)

⁵ At the 21st Conference of Parties (COP21) of the United Nations Framework Convention on Climate Change (UNFCCC) held in Paris, world leaders reached an agreement to maintain the increase of the average global temperature at 2oC. The Paris Agreement encouraged countries to make individual and voluntary commitments - Nationally Determined Contributions (NDCs) - to contribute to this global objective, which entered into force on November 4, 2016 (World Bank, Ecofys and Vivid Economics, 2016).

In Brazil, the National Policy on Climate Change (NPCC) and the NDC have established the voluntary commitment to reduce emissions. In this context, the Ministry of Finance created the Executive Committee and the Project Working group - PMR (Partnership for Market Readiness), which intend to evaluate the opportunity and convenience of implementing the emission pricing – by means of tax and/or carbon market – to support the achievement of the Brazilian NDC and as one of the NPCC instruments after 2020. In the context of the PMR, potential impacts of a carbon pricing model in different sectors of Brazilian economy are under study.

Depending on how they are followed, such policies may represent, on one side, a systemic risk, and on the other side, opportunities for investments in projects and companies aiming at lower carbon emissions.⁶ As such, climate policies and market dynamics have made the investors consider the risk associated with loans and investments in physical carbon-intensive assets and the need to be prepared for the potential carbon pricing impact on companies of the productive sector, their clients.

In this context, given the relevance of climate change and its potential impacts on the economy, carbon represents an important source of risk not only for the productive sector, but also for the financial sector. That way, the objectives of this study are:

- ✓ To identify the trends associated with high carbon emissions and concentrations (“carbon risk”), including pricing;
- ✓ To map the carbon risk management practices by companies of selected economy sectors;
- ✓ To identify the material sector-related topics to be considered by the financial institutions in carbon risk management and their analyses of socio-environmental risk; and
- ✓ To identify the potential opportunities for financial institutions, which are derived from carbon risk management.

⁶ (Battiston, Mandel, Monasterolo, Schutze, & Visentin, 2017)

2. Carbon risk management

According to the most recent report from the Intergovernmental Panel on Climate Change (IPCC), anthropogenic greenhouse gas emissions (GHG) have increased since the pre-industrial period as a result of economic and population growth. Effects of increased concentration of such gases in the atmosphere have been identified in climate system and considered the main cause of increased global average temperature – global warming – noted since the middle of 20th century.⁷ That warming has resulted in changes to climate patterns – known as climate change – which result in such effects as more frequent droughts, more intensive rains and glacier melting.⁸

To limit climate change impacts it is necessary to reduce GHG emissions (the so-called emission mitigation) through the reorganization of the productive systems and incentives that influence the decisions on consumption and investment. Additionally, it is a consensus that even if ambitious mitigation commitments are achieved in the near future, it will be necessary to prepare for impacts that inevitably will occur in the next years – the so-called adaptation that includes the adjustment to climate stimulus – current or expected – and their effects, to minimize or prevent damages or explore opportunities.⁹

By considering that climate change imposes risks to the companies' operations and their results – which are caused by factors such as increased resource shortage, changes to prices and competitiveness, existence of carbon-related regulations and change to consumers' preference –, integrating the topic to corporate risk management becomes essential for businesses.¹⁰ Carbon risk management involves strategic and operational actions in mitigation and adaptation fields to reduce the negative impacts on businesses and increase the opportunities related to climate change. The first step to an effective carbon risk management is to understand the risks and opportunities that climate change may represent for businesses.

⁷ (IPCC, 2013)

⁸ (Kennedy & Lindsey, 2015)

⁹ (GVces, 2015)

¹⁰ (Busch & Hoffmann, 2007)

Climate-related risks and opportunities and financial impacts

The Task Force on Climate-related Financial Disclosures (TCFD) published, in June 2017, the final version of recommendations on financial disclosures related to the climate,¹¹ thus providing a standardized framework for identification of risks, its impacts and report to be adopted by G20 countries. That document provides a categorization of risks and opportunities related to climate, which are described in Box 1 and Box 2, respectively.

Risks are related to two aspects: transition to a low-carbon economy and physical impacts from climate change. Transition risks are related to political, legal, technological, and market changes to meet the requirements of climate change mitigation and adaptation. On the other hand, physical risks derived from climate change may be acute – related to extreme events – or chronic – related to long-term changes to climate standards.

Box 1. Risks related to climate: concepts

TRANSITION RISKS

Policy and Legal: political risk is related to the financial impacts from political changes to restrict actions that contribute to intensifying the adverse effects of climate change or promoting adaptation actions. The legal or litigation risk is related to the increased amount of losses and damages derived from climate change due to such factors as the organizations' inability to mitigate and/or adapt themselves, as well as insufficient disclosure of material financial risks related to climate.

Technology: related to technological improvements and innovations for transition to a low carbon economy, which may affect the organizations' competitiveness, their production and distribution costs and the demand for products and services.

Market: related to changes to supply and demand of certain commodities, products and services as the matters related to the climate are considered in the decision-making processes.

Reputational: related to the change of perceptions of clients or other stakeholders in relation to the positive or negative contribution of an organization to the transition to a low-carbon economy.

PHYSICAL RISKS

Acute: derived from events, what includes the increased intensity and frequency of extreme climate event, such as cyclones, hurricanes and floods.

Chronic: related to changes to climate patterns that are likely to cause, for example, the rise of sea levels.

Source: Adapted from (TCFD, 2017)

¹¹ (TCFD, 2017)

In turn, opportunities related to efforts for the mitigation of climate change and adaptation to it have been identified in five areas: efficient use of resources, adoption of low-emission power sources, development of new products and services, access to new markets and construction of resilience across the supply chain.¹²

Table 2. Opportunities related to climate: concepts

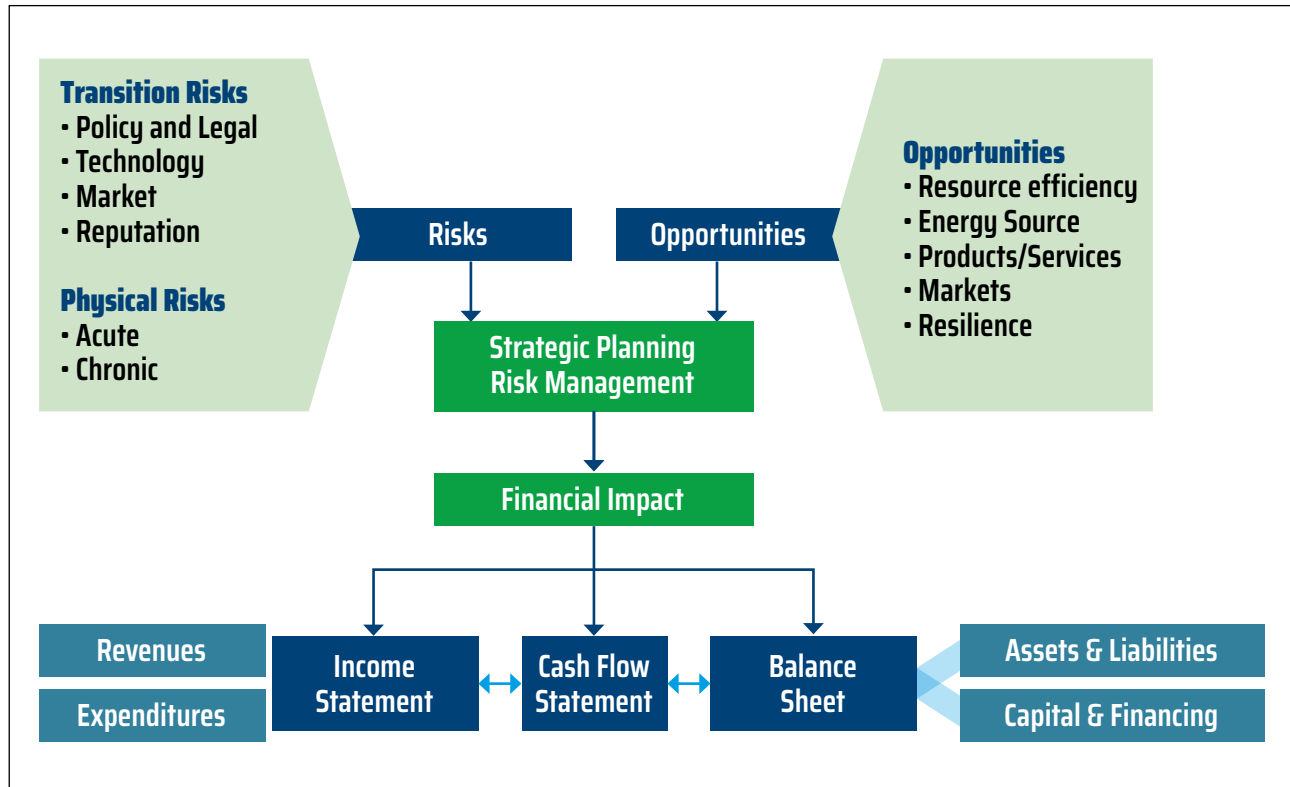
OPPORTUNITIES
Resource Efficiency: related to the reduction of operational costs derived from the improved efficiency of processes and products. That efficiency may be energy or water efficiency or residue or other material management efficiency.
Energy Source: related to the reduction of current energy costs derived from the use of low-emission energy sources, such as solar, wind, hydro, geothermal and biofuel energy.
Products and Services: related to the improvement of competitive position and utilization of consumers and producers' preferences by organizations that innovate and develop low-emission products and services.
Markets: related to access to new markets and financing sources for companies that want to diversify their activities and achieve a better position for the transition to a low-carbon economy. Access to new markets may be made by cooperation with governments, development banks, and local entrepreneurs, among others. Financing sources include green bonds and financing of more efficient infrastructures.
Resilience: related to the improvement of efficiency, projection of new processes for production and development of new products by organizations intended to develop their capacity of adaptation to climate change. Such opportunities are especially relevant for organizations having long-lived fixed assets, extensive supply or distribution networks, high dependence on natural resources or infrastructure network along its value chain, and organizations that require long-term financing and investment.

Source: Adapted from (TCFD, 2017)

To make well-informed decisions, financial institutions need to identify not only the risks and opportunities derived from climate change for economy in general, but also how such risks and opportunities may impact the financial position of their clients and invested companies – in income statement, cash flow and balance sheet. That relation is systematized in Figure 1 and Annex 1 provide some examples.

¹² (TCFD, 2017)

Figure 1. Climate-related risks and opportunities and financial impacts



Source: (TCFD, 2017)

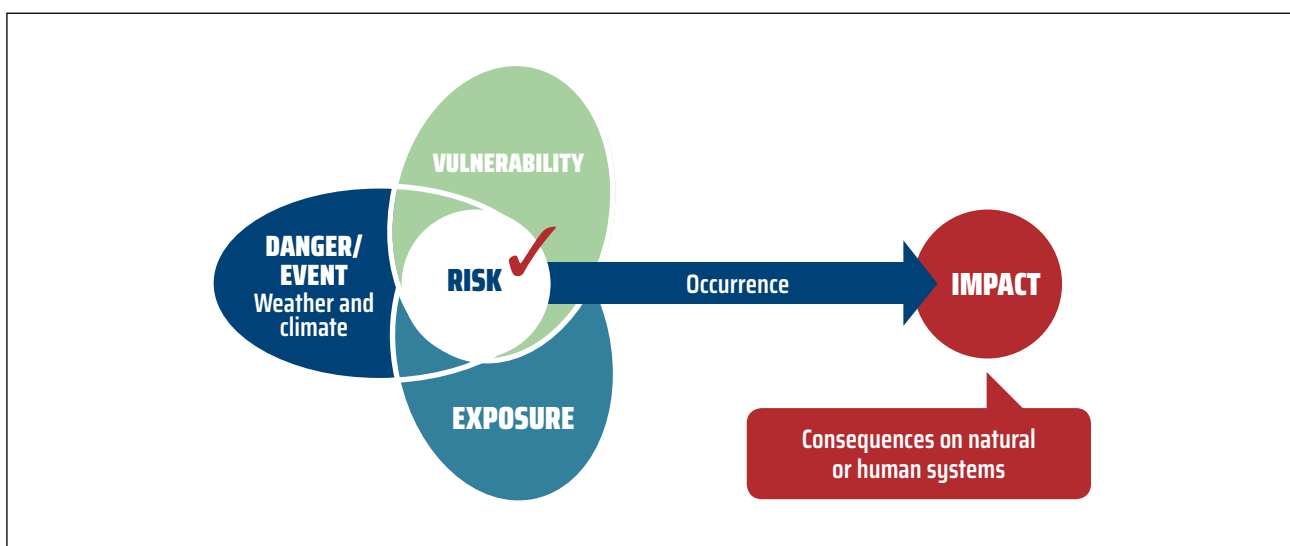
As regards the income statement and cash flow statement, the company's revenues may be positively or negatively impacted by a change in prices and costs or demand for products and services generated by physical and transition risks. The companies' expenses may also be impacted, as an organization's capacity to answer to risks and opportunities related to the climate depends, among other factors, on the adopted technology, its cost structure and its flexibility to change it. Thus, the resilience of investment plans will depend on the organizations' flexibility to change their allocation of capital and the market's interest in financing organizations exposed to significant levels of climate-related risks¹³.

¹³ (TCFD, 2017)

As regards the balance sheet, the evaluation of the organizations’ assets and liabilities may be impacted by changes in supply and demand derived from changes in policies, technologies and market dynamics related to climate change. In particular, matters related to climate may affect long-term assets. Therefore, it is important that companies disclose the potential expected impacts on their assets and liabilities in the context of current or future decisions requiring new investments and productive model restructuring. In addition, climate-related risks and opportunities may impact the capital and financing of organizations because of the change in debt and the ownership structure profile, whether for the increased debt levels to offset reductions of operational cash flows or for new capital or research and development expenses.¹⁴

Although climate change affects all economic sectors, the size of risk and generated impacts are different according to several factors, such as exposure and vulnerability. As shown in Figure 2, the danger is strongly associated with the probability of the climate event to occur and cause damage. The vulnerability of a system is related to its capacity to deal with the effects of the climate event. Exposure, on the other hand, is related to the fact of being present in places that can be affected by the climate event.

Figure 2. Illustration of basic concepts



Source: Adapted from (IPCC, 2012)

¹⁴ (TCFD, 2017)

The risk of climate-related impacts results, therefore, from the interaction of climate events with the vulnerability and exposure of natural or human systems. When risk materializes, there is an effective impact that can be higher or lower depending on the magnitude of the climate event and the vulnerability and exposure level of the system. In this context, risk management strategies of each company may contribute to increase or reduce its level of vulnerability and exposure to risk and, consequently, the magnitude of the generated impacts.

Climate-related Financial Disclosures

To manage and report the organizational efforts to implement mitigation and adaptation measures, TCFD suggests that strategies and actions by organizations shall cover four thematic areas that represent the basic indications of how organizations operate: (i) **governance**: supervision by the council and the role of top management in the evaluation of risks and opportunities related to climate change; (ii) **strategy**: strategies for risks and opportunities related to climate change in the short, medium and long term, their impacts on financial and business planning, evaluation of the company's resilience in different climate change scenarios, adoption of new technologies, markets and productive processes; (iii) **risk management**, taking into account the company's process of identifying, evaluating and managing the risks related to climate change; and (iv) **metrics and targets**, including the disclosure of inventories of GHG emissions and targets adopted by the company to reduce and manage emissions.¹⁵

The four general recommendations (Figure 3) are supported by disclosure recommendations (Annex 2) that help the investors and other stakeholders to understand how the organizations evaluate climate-related risks and opportunities.

¹⁵ (TCFD, 2017)

Figure 3. Recommendations on disclosure categories proposed by the Task Force on Climate-related Financial Disclosures.

GOVERNANCE	STRATEGY	RISK MANAGEMENT	METRICS AND TARGETS
<p>Disclosure of organization’s governance around climate-related risks and opportunities.</p>	<p>Disclosure the actual and potential impacts of climate-related risks and opportunities on the organization’s businesses, strategy, and financial planning where such information is material.</p>	<p>Disclosure how the organization identifies, assesses, and manages climate-related risks.</p>	<p>Disclosure the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material.</p>
<ul style="list-style-type: none"> • Does the board supervise climate-related risks and opportunities? • What is the role of management/managers in the assessment and management of risks and opportunities? 	<ul style="list-style-type: none"> • What are the risks and opportunities identified by the organization in the short, medium and long-term? • What are the impacts of climate-related risks and opportunities on the organization’s business, strategy, and financial planning? • By considering different climate-related scenarios, including a 2°C or lower scenario, how resilient is the organization’s strategy? 	<ul style="list-style-type: none"> • Does the company have a process to identify and assess risks? And to manage such risks? • How does that process work? • How are such processes for identifying, assessing, and managing such risks integrated to the general risk management framework of the organization? 	<ul style="list-style-type: none"> • Which metrics are used to assess such risks and opportunities? How are such metrics aligned with the company’s strategy and risk management process? • Which are the company’s emissions under scopes 1, 2 and 3? What are the related risks? • What are the targets used by the company to manage such risks and opportunities? How has the company’s performance been with regard to such targets?

Source: Adapted from (TCFD, 2017)

By taking into consideration the three factors that are most likely to be affected by transition and physical risks – GHG emissions, energy production and usage, and water – TCFD has established four economic and industrial groups with a significant exposure to climate-related risks: energy; transportation; materials and buildings; and agriculture, food and forest products (Table 1). For these four sectors and the financial sector, TCFD has developed supplementary guidelines (Annex 2) to emphasize important sectorial considerations and to provide a more comprehensive image of potential climate-related financial impacts on them.

Table 1. Associated groups and industries with the highest exposure to climate-related risks:

ENERGY	TRANSPORTATION	MATERIALS AND BUILDINGS	AGRICULTURE, FOOD AND FOREST PRODUCTS
<ul style="list-style-type: none"> • Oil and Gas • Coal • Electrical Utilities 	<ul style="list-style-type: none"> • Air Freight • Passenger Air Transportation • Maritime Transportation • Rail Transportation • Trucking services • Automobiles and Components 	<ul style="list-style-type: none"> • Metals and Mining • Chemicals • Construction Materials • Capital Goods • Real Estate Management and Development 	<ul style="list-style-type: none"> • Beverages • Agriculture • Packaged Foods and Meats • Paper and Forest Products

Source: (TCFD, 2017)

One of the main disclosures recommended by the TCFD involves the resilience of the organizations strategy, considering different climate-related scenarios, including a scenario of an average temperature increase of 2°C. Disclosing how strategies may change to address possible climate-related risks and opportunities is a basic step to understand the possible impacts of climate change on the organization. The TCFD understands that said analysis is relevant to increase the disclosure of financial information related to the climate that is significant for the decision-making process, but it recognizes that the use of scenarios and its possible financial implications are relatively recent and that such practices will develop along the time.

Furthermore, the TCFD recognizes the organization’s challenge in identifying, assessing and reporting the financial impacts from risks and opportunities that are more material for its business due to such factors as limited knowledge of the topic across the organization, the tendency to focus on short-term risks without considering long-term risks, as well as the difficulty in quantifying the financial effects related to climate change impacts, as they are rarely clear or direct.

3. Carbon pricing outlook

If the evaluation of climate risks and their potential impacts represents a challenge to the productive sector – which is directly affected by climate change – these challenges become even more complex in the context of financial institutions, which are predominantly affected indirectly by climate change. For that reason, assessing the impact of climate risks and climate policies on the financial system is currently considered as one of the most urgent and prominent matters.¹⁶

In particular, there is interest with respect to the climate policies aimed to reduce GHG emissions, as they may affect, positively or negatively, the revenues and costs of several real economy sectors by generating indirect effects on the financial players that hold securities of companies included in such sectors. Depending on how they are conducted and implemented, such policies may represent, on one side, a systemic risk, and on the other side, opportunities for low carbon emission investments and economic growth.¹⁷

Such risk is included in the “Policy and Legal” category proposed by the TCFD, which includes, among other things, the GHG emission pricing. The increasing adoption of carbon pricing as a mechanism to regulate GHG emissions is considered a significant risk to sectors of intensive emissions and may also represent opportunities for low-carbon sectors. Therefore, it is relevant that industries to be affected by this instrument consider its potential impacts on their revenues and that the banks evaluate the potential carbon pricing impacts on their financing portfolios.

¹⁶ (Battiston, Mandel, Monasterolo, Schutze, & Visentin, 2017), p. 283; (Carney, 2015); (ESRB Advisory Scientific Committee, 2016).

¹⁷ (Battiston, Mandel, Monasterolo, Schutze, & Visentin, 2017)

Concept, scope and limitations

There are two categories of instruments for policy and environmental management: economic and command and control instruments. For command and control instruments – or regulatory – the public power establishes the standards and monitors the environmental quality by regulating the activities and applying sanctions and penalties according to laws and regulations. They are legally established and give no flexibility to the economic agents to select the best way to solve the problem.

Economic instruments, in turn, are those that affect the calculation of the economic agent's costs and benefits by influencing its decisions and consequently improving the environmental quality. Such instruments aim to incorporate the social costs to individual decisions of economic agents. For such reasons, most of the discussions on environmental policy at international level are guided by the economic theory that is based on the concept of externality.¹⁸

Externalities emerge when a real variable selected by an economic agent is inserted in the production or utility function of other economic agents and that first agent is not required or stimulated to consider the effects generated by its choices on others.¹⁹ Taking into account that environmental degradation represents a discrepancy between private costs and social costs for the society, the environmental policy suggests the application of economic instruments that motivate the agents to consider the social costs in their individual decisions.

Economic instruments allow a better economic flexibility to agents, as they are free to select the most cost-effective way to achieve the expected target.²⁰ As such, carbon pricing is characterized as an economic instrument to incorporate externalities related to GHG emissions, thus reducing their costs and creating incentives for the innovation of low-carbon businesses.

¹⁸ (Almeida, 1998)

¹⁹ (Freeman III, 2003)

²⁰ (Almeida, 1998)

Defined as “a mechanism to reflect the social, environmental and economic costs of climate change in financial decisions”,²¹ the term “carbon pricing” means assigning a price to carbon. That price may be linked to different approaches (Figure 4): mandatory (external pricing) and voluntary (internal pricing).

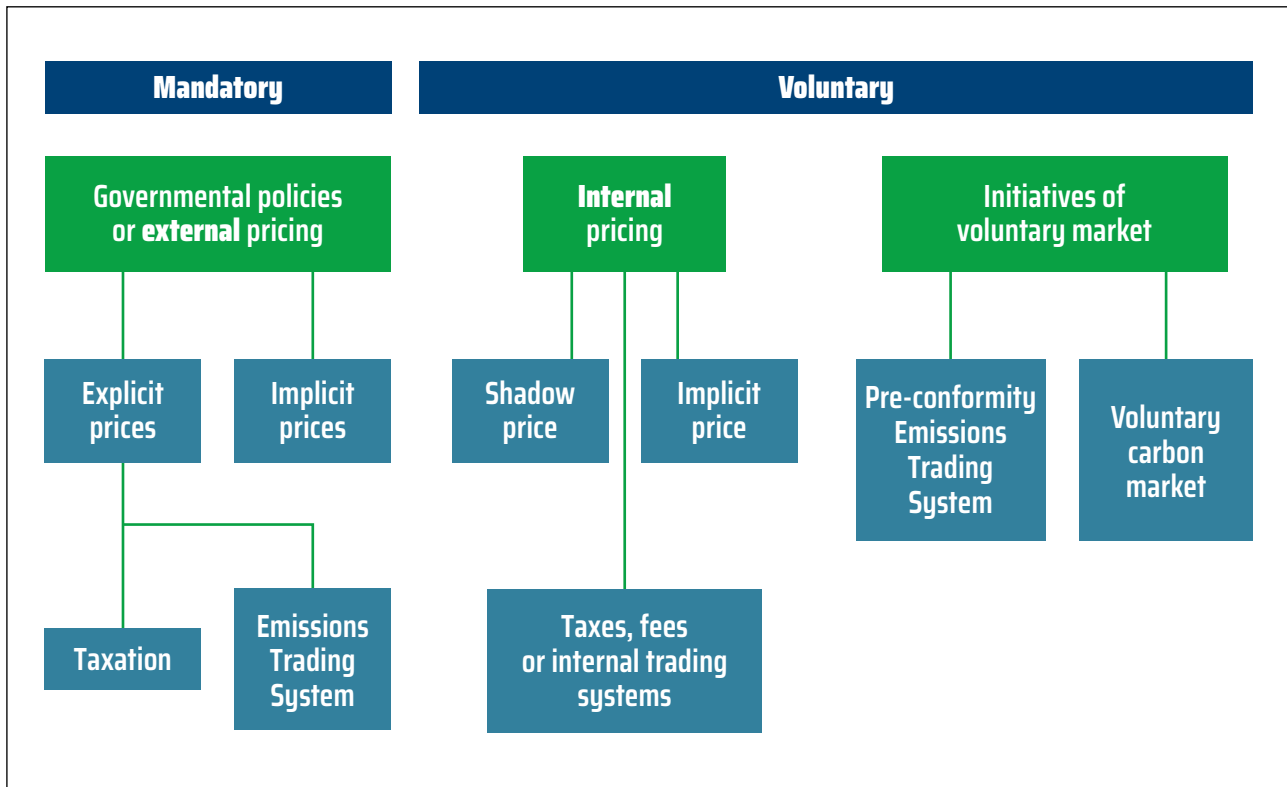
Mandatory pricing derives from governmental policy. These external prices may be explicit charges, such as taxes on emitted GHG or prices of carbon emissions permission adopted in a Emissions Trading System (ETS). They may also be implicit, that is, calculated by the companies based on the cost of their conformity with regulations related to GHG emissions reduction.

For **voluntary pricing**, on the other hand, the companies adopt internally a theoretical carbon price to consider GHG emissions in the decision-making processes, particularly on investments. It may be calculated and implanted by means of three approaches that are more usual: shadow price; implicit price; or internal taxes, fees or trading systems.²² In addition to internal price, the companies may participate in ETS simulations and voluntary carbon markets as a part of their strategic efforts to reduce emissions and preparation for future regulations.

²¹ Translated from (UN Global Compact, 2015), p. 6 and 7.

²² (FGVces, 2016a)

Figure 4. Different carbon pricing approaches



Source: (FGVces, 2016a)

Carbon price must be adopted as a component of a higher approach (both from public policy and corporate practice standpoint) as that mechanism alone will not necessarily reflect all externalities associated with climate change – that is, all social, environmental and economic costs – and cannot lead to necessary changes in the necessary scale and speed.

Mandatory pricing: taxation and emissions trading system

Most global governments – 189 countries accounting for 96% of GHG emissions and 98% of the world population – have committed to reduce their emissions and adapt to climate change by means of their Nationally Determined Contributions²³ (NDC). After such commitments are made, it is necessary to ensure their fulfillment by means of mechanisms that are able to influence decisions on investment and consumption.

For that, the NDCs will depend on several policies and programs, including the carbon pricing initiatives, provided that around 100 jurisdictions – accounting for 58% of global GHG emissions – are considering the implementation of this instrument.²⁴ Until May 2017, 42 national jurisdictions and ²⁵ sub-national jurisdictions (Annex 3), accounting for approximately 15% of global GHG emissions and a market value of some US\$ 52.2 billion, have set a price for carbon²⁵ by means of taxes or emissions trading systems (ETS).

Taxation consists of charging a tax to the responsible for the imposition of external costs – in this case, GHG emission – on others. This approach, in addition to generating revenues for the government, requires no governmental intervention in decisions made by companies to emit GHG or not.²⁶ However, that instrument has the challenge of setting the adequate tax value to meet the target established for GHG reduction. Tax effectiveness depends on the elasticity of supply and demand for a good or resource, as for goods of inelastic demand the tax price may be mostly transferred to consumers without impacting the company's strategy in terms of quantity to be produced or reduction of its environmental impact.²⁷

²³ At the 21st Conference of Parties (COP21) of United Nations Framework Convention on Climate Change (UNFCCC) held in Paris, the world leaders reached an agreement to maintain the increase of average global temperature at 2°C. Paris Agreement stimulated the countries to make individual and voluntary commitments – Nationally Determined Contributions (NDCs) – to contribute to that global objective, which entered into force on November 4, 2016 (World Bank, Ecofys and Vivid Economics, 2016).

²⁴ (World Bank, Ecofys and Vivid Economics, 2016)

²⁵ (World Bank Group & Ecofys, 2017)

²⁶ (Mankiw, 2009)

²⁷ (FGVces, 2017a)

By considering the difficulty in establishing an excellent taxation and foreseeing its impact on the companies' strategy, there is also the alternative of the **emissions trading system** (cap-and-trade), based on the logic of setting an excellent quantity of emissions and letting the market set the price to be paid by externalities. That mechanism consists of determining a total level of emissions and thereafter distributing across the productive sector the permission of volumes amounting to the total established. Such permissions may be traded among several sectors, and those sectors with total emissions lower than their allocation may sell their excess to those with total emissions exceeding their allocation.²⁸

It is also possible to develop hybrid approaches in which some economy sectors are charged while others are regulated by emissions trading systems.

Carbon prices adopted by currently existing initiatives (Annex 4), both related to tax and market, vary by less than US\$ 1/tCO₂e to US\$ 126/tCO₂e. Some 75% of emissions covered by such initiatives have a price below US\$ 10/tCO₂e, being higher prices necessary to increase the economic impact of carbon price and contribute to achieve the Paris Agreement objective.²⁹

The first emissions trading system (ETS) entered into operation in 2005 in the European Union (European Union Emissions Trading System – EU ETS), covering 1.9 billion tons of carbon equivalent (tCO₂e) in 2017. ETS initiatives continued to grow over the last decade and by the end of 2017, the ETS regulated approximately 7.4 billion tons of GHG emissions with 19 systems operating all over the world in economies that generated almost half of the world's gross domestic product and covering more than 15% of global emissions. As the number of systems and market maturity increase, there is a trend of connection among the ETS, like in the joint program in California and Quebec and more recently between the European Union and Switzerland. That trend of linked carbon markets is also stimulated by Paris Agreement in its article 6.³⁰

²⁸ (FGVces, 2017a)

²⁹ (World Bank Group & Ecofys, 2017)

³⁰ (ICAP, 2017)

Most existing systems consider the power and industry sectors,³¹ while some also consider the buildings, transportation and aviation sectors, and a few of them already consider the waste and forestry sectors.³² As such, there is flexibility in an ETS design to match different economic profiles. In existing systems, prices range from US\$ 2 to US\$ 15, due to different costs of emission reduction and market conditions, such as liquidity.³³

The first taxes were implemented in 1990 in Finland and Poland, and by the end of 2017, it is expected that 22 initiatives will be in force. Three Latin American countries have taxation initiatives: Mexico, Chile and Colombia.

Mexico introduced, in 2014, a tax on sales and imports of fossil fuels, excluding natural gas, in the amount of US\$ 3.50/tCO₂. In that same year, the National Registry of Emissions was established, which required the power, industry, transportation, agriculture, waste, commercial and service sectors to report their direct and indirect emissions higher than 25,000 tCO₂e. In 2016, the Mexican Stock Exchange (BMV Group), MEXICO₂ (BMV voluntary carbon market platform) and the Ministry of Environment and Natural Resources (SEMARNAT) signed a cooperation agreement to implement a voluntary emissions trading system for which the participation of more than 60 companies of power generation, industry and transportation sectors are expected. The objective of that initiative is to make the involved parties familiar with the ETS concepts, being therefore one of the steps for the implementation of a regulated carbon market in 2018.³⁴

³¹ Examples: textile, mechanical, iron and steel and petrochemical companies.

³² Out of 19 existing systems, 18 cover industry, 16 cover energy, 10 cover construction, 7 cover transportation, 7 cover aviation, 2 cover residues and 1 covers silviculture (ICAP, 2017).

³³ (ICAP, 2017)

³⁴ (ICAP, 2017)

Chile, in turn, introduced the taxation in September of 2014, as a part of a broader tax reform. The tax is due on thermal power generators with a thermal input of 50 MW of more, excluding the biomass power plants. As of 2018, emitters will have to pay US\$ 5/tCO₂ in addition to a tax on local pollutants (SO₂, NO_x and particles). In 2015, a tax on particles and NO_x also entered in force, which is a single payment on new vehicles based on their respective purchase price, fuel consumption and emissions of NO_x/km.³⁵ The country considers it as a hybrid model, by studying the taxation deepening and the ETS implementation.

In Colombia, on the other hand, a tax of about US\$ 5/tCO₂ entered in force in January 2017, which is due on all liquid and gaseous fossil fuels used for combustion. Fossil fuels derived from oil and gas account for approximately 24% of total emissions of GHG in the country, being expected that the tax will contribute to reduce more than 4 million tCO₂ between 2017 and 2030. Received revenues will be allocated to mitigation and adaptation actions – such as the preservation of hydrographic basin, protection of ecosystems and management of coastal erosion – and the national fund for peace.³⁶ The country also considers it as a hybrid model of ETS and tax.

At regional level, a discussion on a potential regional carbon market has started in Latin America, to be designed within the scope of the Pacific Alliance composed of Chile, Colombia, Mexico and Peru. The Cali Statement, signed in June 2017, aims to strengthen the regional climate action and cooperation.³⁷

³⁵ (ICAP, 2017)

³⁶ (CPLC, 2017a)

³⁷ (IETA, 2017)

Also, in December 2017, the Paris Declaration on Carbon Pricing in the Americas was launched. By that declaration, the leaders of the governments of Canada, Chile, Colombia, Costa Rica and Mexico, the governors of California and Washington, and the premiers of Alberta, British Columbia, Nova Scotia, Ontario and Quebec have reaffirmed their commitment to the Paris Agreement and undertaken to implement carbon pricing instruments in the Americas. That initiative recognizes the role of carbon pricing in the reduction of emissions and promotion of innovation and seeks to align policies and pricing systems to support the reduction of risk of carbon leakage³⁸ and address matters of competitiveness among jurisdictions.³⁹

Voluntary pricing: internal carbon price

In parallel with mandatory pricing, several companies are already adopting voluntarily an internal price for carbon as a way to prepare themselves for the impact from future laws on their operation or value chain. In 2017, 51 companies in Brazil reported the use or intended use of an internal carbon price,⁴⁰ as compared to 47 companies in 2016 and 27 in 2015,⁴¹ which represents an increase of more than 80% over the last two years. At world level, 1,389 companies reported in 2017 the adoption or intended adoption of an internal carbon price,⁴² provided that a similar number of them supports the implementation of carbon pricing policies to redirect investments.⁴³

³⁸ The term carbon leakage refers to a situation where, due to costs related to climate policies, companies transfer their production to other countries where emission restrictions are lower. This risk is higher in industries that have an intensive use of energy and may cause an increase in total emissions (European Commission, 2017).

³⁹ (Paris..., 2017)

⁴⁰ (CDP, 2017c)

⁴¹ (CDP, 2016)

⁴² (CDP, 2017c)

⁴³ (UN Global Compact, 2015)

To set an internal carbon price (monetary unit/ton of CO₂ equivalent) it is necessary that the company first of all determines its general objective: to help in evaluations of risks and opportunities associated with a mandatory pricing scenario in the future, support the company's voluntary emission mitigation strategies and/or help the company to identify and quantify its environmental externalities. Based on the determination of a general objective, a detailed description can be made to specify the objectives, strategies and targets to set internally the price of strategic investments, identification and prioritization of mitigation actions, and awareness of contributors, clients and suppliers, among others.⁴⁴

So far,⁴⁵ internal carbon pricing is made through three different methods. One of them is the **shadow price**, which refers to the definition of an assumed cost of the company's GHG emissions, to be incorporated into the financial analyses of the organization with the objective of supporting the evaluations of risks, opportunities and impacts associated with each tone of CO₂ emitted. Another method is that of **implicit price**, which is based on the average cost incurred or to be incurred by the company to reduce a ton of CO₂ of its products, operations and/or investments, thus supporting its emission mitigation strategies. Finally, there is the method of fee or **internal market**, which consists of the adoption of an internal fee or internal emissions trading system in the company to foster the achievement of its mitigation objectives. The internal fee allows business units to be financially charged according to their emission levels, while the internal ETS allows the transaction of permits in the organization for CO₂ emission.⁴⁶

Ultimately, there are different methods that may be used to establish the internal carbon price to be adopted. One of them is the social cost of carbon (SCC) that estimates the costs of possible impacts of GHG emission on human welfare. Another method is the marginal abatement cost (MAC) that indicates the cost of reducing an additional tCO₂e. It is also possible to set the carbon price based on prices adopted in ETS or existing taxes, or based on prices already adopted by other companies that have similar internal pricing objectives.⁴⁷

⁴⁴ (FGVces, 2016b)

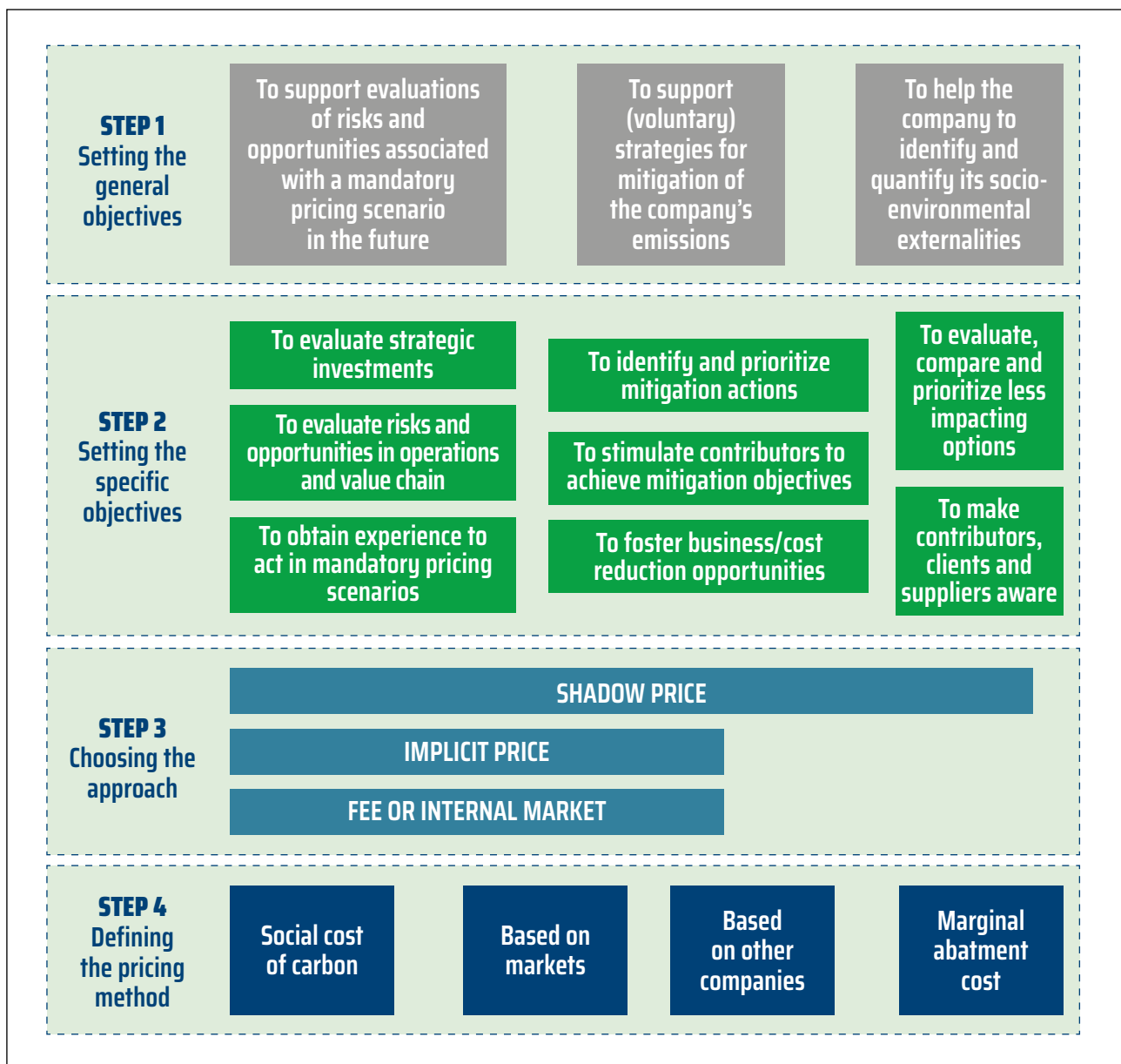
⁴⁵ Internal carbon pricing is a relatively new topic and therefore it is possible that new approaches will emerge or existing approaches will be improved.

⁴⁶ (FGVces, 2016b)

⁴⁷ (FGVces, 2016b)

Figure 5 shows step-by-step the way to establish an internal carbon price. It is important to point out that internal carbon pricing is not an objective in itself, but is rather a way to achieve different objectives. The process of establishing the company’s objectives, understanding why to price internally and which approaches may be used internally are more important than reaching a “correct price”, as that is a dynamic process that must be constantly adjusted according to new information and understandings.

Figure 5. Steps to establish an internal carbon price



Source: (FGVces, 2016b)

To help market players to set the carbon prices necessary to make different economic sectors comply with the Paris Agreement, the CDP and We Mean Business Coalition launched in 2017 the Carbon Pricing Corridors initiative. For the period of two years, the Corridors Panel – a group of corporate experts, investors and international experts – intend to identify the range of carbon prices necessary until 2020, 2025 and 2030 to allow the more polluting industrial sectors to follow a way to achieve the long-term objectives of economy decarbonization. The first studied case was that of the power sector and other sectors of high emissions will be included along the next years.⁴⁸

Carbon pricing in Brazil

In Brazil, the National Policy on Climate Change (NPCC), established in 2009 by Law no. 12,187, officialized the Brazilian voluntary commitment to the United Nations Framework Convention on Climate Change to reduce GHG emissions by 36.1% and 38.9% of emissions projected until 2020 official.⁴⁹ In its NDC, Brazil undertook the commitment to reduce its GHG emissions by 2025 by 37% below the levels in 2005,⁵⁰ that is, 1,300 MtCO₂e.

To support the implementation of the Brazilian NDC and as one of the NPCC instruments after 2020, Brazil is one of 18 countries⁵¹ that are currently studying carbon pricing under the PMR Project – Partnership for Market Readiness: a forum of countries and international organizations aiming to foster actions to mitigate climate change. Coordination and guidance of activities of the PRM Project – Brazil are made by the Executive Committee composed of the Ministry of Finance (represented by the Department of Economic Policy and Department of International Affairs) and the World Bank.

⁴⁸ (CDP & We Mean Business Coalition, 2017)

⁴⁹ (MMA, without date)

⁵⁰ (Federative Republic of Brazil, 2016)

⁵¹ In addition to Brazil, the other 17 countries that have implemented the PMR Project are: South Africa, Argentina, Chile, China, Colombia, Costa Rica, Indonesia, Jordan, Mexico, Morocco, Peru, Sri Lanka, Thailand, Turkey, Ukraine and Vietnam (PMR, 2016).

In the PMR context, the potential impacts from the implementation of a carbon pricing model in the following sectors of the Brazilian economy are being studied: power (electric power generation and fuels); the seven subsectors of Sectorial Mitigation and Adaptation Plan in Transformation Industry (steel, cement, aluminum, chemical, lime, glass and paper and cellulose industries); and livestock.⁵² At the end of the project expected to occur in 2019, the recommendation to adopt pricing instruments shall be made upon the existence of sufficient evidence that they contribute to reduce the cost of achievement of scheduled targets and are consistent with other public policies.

In voluntary terms, the Business Initiative in Climate (IEC, its Portuguese acronym) – composed of the Carbon Disclosure Project (CDP), the Center for Sustainability Studies at the Getulio Vargas Foundation (FGVces), the Brazilian Business Council for Sustainable Development (Cebds), Envolverde, the Ethos Institute and the Brazilian Network of UN Global Compact – published in September 2016 its position about the carbon pricing mechanisms with the objective to “promote the engagement of corporations in discussion and to communicate to the government its view and willingness to contribute to that agenda”.⁵³

Motivated by the main emissions trading system, since 2013 the FGVces has simulated with a group of Brazilian companies a cap and trade system. That initiative aims to create and disseminate know-how across the corporate sector about the operation of an ETS, its impacts on business and potential contribution to achieving the targets for the reduction of GHG emissions in a cost-effective way. In 2017, that Simulation had the participation of 35 companies (Annex 5) from different sectors⁵⁴ of the Brazilian economy, including two financial institutions. The ETS Simulation covered that year approximately 137.6 million tCO₂e, which represents about 13% of the national emissions in 2015, without considering the emissions derived from land use change.⁵⁵

⁵² (SPE, without date)

⁵³ (IEC, 2016)

⁵⁴ In 2017, an Emissions Trading System Simulation achieved the following sectorial representation: industry 47%, energy 17%, agribusiness 14%, transportation and logistics 8%, mining 6%, and retail 3%.

⁵⁵ (FGVces, 2017b)

Within the scope of voluntary internal pricing initiatives, the FGVces Business for Climate Platform⁵⁶ (EPC, its Portuguese acronym) developed in 2016, jointly with 30 companies operating in Brazil, the Business Guidelines for Internal Carbon Pricing (DEPIC, its Portuguese acronym). According to a survey made by that initiative to prepare the guidelines contained in DEPIC, many companies are still unsure about deciding among the several options for pricing carbon internally, as they are at the initial stage of understanding that process. That way, the Guidelines aim to support the companies at this first moment, by providing practical guidance to help them to set the objectives and apply the different approaches to determine carbon price internally.⁵⁷

⁵⁶ EPC is a corporate platform whose objective is to sensitize and engage corporate leaderships in the management and reduction of greenhouse gas emissions and the management of climate risks, in addition to proposing public policies for a low-carbon economy (FGVces, c2014).

⁵⁷ (FGVces, 2016a)

4. Carbon pricing and financial institutions

In addition to the increase of carbon pricing adoption by the productive sector, more than 400 investors representing assets amounting to more than US\$ 24 trillion are emerging as carbon pricing supporters to help to adjust their investment.⁵⁸ For banks, internal carbon pricing may be used with the objective of supporting evaluations of risks and opportunities associated with a mandatory pricing scenario in the future. More specifically, it allows the evaluation, comparison and prioritization of strategic investments, by identifying high-risk clients in terms of GHG emission.

Different from the productive sector – for most of which the use of internal carbon pricing method makes sense for their own operation given the high GHG emissions in its scope 1 – for banks, carbon pricing must be considered and applied to their portfolio, as their carbon footprint related to projects under which they invest or grant financing (scope 3) is significantly higher than their own operational activities.

In this context, the Carbon Pricing Leadership Coalition (CPLC), a voluntary initiative intended to catalyze actions for a successful implementation of carbon prices worldwide, created the sectorial group “Banking Sector Task Team” in the “Mobilizing Business Support”⁵⁹ working group. The objective of this group is to share experiences, methodologies and challenges faced in a non-public environment, both to incorporate a carbon price to banking processes and implement TCFD guidelines, thus allowing the banks to learn with one another and discuss potential solutions.⁶⁰

⁵⁸ (Global Investor Statement on Climate Change, 2014)

⁵⁹ The priority of the Corporate Support Mobilization working group in 2017 is to apply efforts to the corporate disclosure and internal carbon pricing with an increasing interest in measuring and managing climate risk. CPLC counts on other three working groups: “Fostering Government Leadership”, “Building and Sharing the Evidence Base” and “Communications Network”.

⁶⁰ (CPLC, 2017b)

In terms of carbon pricing, the working group compiles in their meetings some approaches by which carbon risk has been incorporated to financial analyses: incorporation of a carbon price only for project finance; for corporate and project finance; for analysis of financial risks of investments or credit with impacts related to natural capital; and in the form of policies, excluding some types of investments, such as coal-based projects.

Although the approaches may vary in terms of scope and methodology, it was indicated that most banks face the same challenges as the companies to advance in the use of that instrument, such as the measurement of costs related to climate change to persuade the decision makers, the resistance to request clients for more information in terms of carbon risk, and the resistance to implement a carbon price in when sectorial peers are not doing the same, what may lead to loss of competitiveness. Other challenges involve determining the appropriate carbon price and methodological issues, such as the consideration of scope-3 emissions, the incorporation of carbon price in the analyses of discounted cash flow, and the capacity of financial institutions' clients to pass on the costs associated with carbon pricing.

In a broader context related to the management of climate-related risks and opportunities, the TCFD considers that disclosures by the financial sector may contribute to promote an early evaluation of such risks. In this sense, additional disclosure recommendations are given to four financial sector segments: banks, insurance companies, asset managers and asset owners (including public and private services, sectorial social security plans, donations and foundations).

In the context of this report, additional guidelines for banks and asset managers are highlighted, which are described below in boxes 1 and 2.

Box 1. TCFD additional recommendations to banks

With regard to risks and opportunities identified in the short, medium and long term (Strategy – Recommendation A), banks are required to describe significant concentrations of exposure to credit and assets related to carbon and consider the disclosure of risks related to climate derived from their credit and other intermediate financial activities.

At the description of processes to identify and evaluate climate-related risks (Risk Management – Recommendation A), banks shall consider characterizing such risks in the context of traditional categories of bank sector risks (such as credit, market, liquidity and operational risks), and describing the existing frameworks of risk classification.

With regard to the disclosure of metrics to evaluation risks and opportunities related to climate (Metrics and Targets – Recommendation A), banks shall provide the metrics used to evaluate the impact of such risks on their credit and other intermediate financial activities in the short, medium and long term. Such metrics shall be separated per industry, geography, credit quality and average payment time. Banks shall also provide the price and percentage of assets related to carbon against the total assets, as well as the amount of loans and other financing operations associated with climate-related opportunities.

Source: (TCFD, 2017)

Box 2. TCFD additional recommendations to asset managers

With regard to the description of impacts of climate-related risks and opportunities (Strategy – Recommendation B), asset managers shall describe the way in which these risks and/or opportunities are considered in relevant products or investment strategies and how each product or investment strategy may be affected by the transition to a low-carbon economy.

At the description of organizational processes to identify, evaluate and manage climate-related risks (Risk – Recommendations A and B), asset managers shall describe how that process occurs for each product or investment strategy. As appropriate, they shall also describe the engagement activities with companies selected to stimulate the data disclosure.

Similarly, the disclosure of metrics used by the organization to evaluate climate-related risks and opportunities (Metrics – Recommendation A) shall be made for each product or investment strategy. When relevant, asset managers shall inform how such metrics have changed over time and the metrics that are considered for investment decisions and monitoring.

Finally, as regards the disclosure of GHG emissions and their related risks (Metrics – Recommendation B), the weighted average intensity of carbon for each product or investment strategy and other metrics considered useful for decision making shall be provided together with the description of the adopted methodology.

Source: (TCFD, 2017)

With the objective of developing analytic tools and indicators to strengthen the evaluation and disclosure of climate-related risks and opportunities, 16 banks have committed to cooperate with the United Nations Environment Programme Finance Initiative (UNEP FI) to pilot the TCFD recommendations. By accounting for more than US\$ 7 trillion, they include: ANZ, Barclays, BBVA, BNP Paribas, Bradesco, Citi, Itaú, National Australia Bank, Norway's DNB, Rabobank, Royal Bank of Canada, Santander, Société Générale, Standard Chartered, TD Bank Group and UBS.⁶¹ Based on that experience, the UNEP FI intends to compile the developed methodologies, tools, metrics and scenarios and publish case studies describing the practical experience of banks and challenges faced during the process to guide other banks to implement the Task Force recommendations.⁶²

In terms of opportunities, there are several roles to be explored by banks in the context of carbon risk management, such as clean technology financing and the design of innovating financing mechanisms related to climate, among others. In particular, there are several opportunities for banks in the context of an emissions trading system. They include the roles of broker (acting as an intermediate of negotiations), market maker (providing liquidity to the market), reduction of transaction costs (aggregating commercial activities of smaller entities), derivatives (negotiating term permits), speculation (negotiating on their own to obtain profit) and market analysis (providing market information by means of publications and newsletters).⁶³

⁶¹ (UNEP FI, 2017a)

⁶² (UNEP FI, 2017b)

⁶³ (Betz & Cludius, 2016); (Betz, Cludius, & Schopp, The Role of the Financial Sector in EU Emissions Trading, 2015)

5. Methodological approaches

To understand how companies and financial institutions are preparing themselves for carbon pricing risk and other risks related to climate change, and how such risks would potentially affect the credit and investment portfolios of banks, this study carried out: (i) an analysis of carbon risk management practices adopted by companies in selected sectors operating in Brazil; and (ii) an analysis of practices adopted by international banks. In both analyses, the carbon pricing risks and the actions adopted for their management were addressed.

The **analysis of practices adopted by banks** aimed to discover the carbon risk management practices adopted by international banks considered advanced in the matter. The survey process took place in the form of interviews with the objective of understanding how and why banks are adopting carbon pricing to assess their client portfolio, and what the risks and opportunities identified in the current scenario of transition to a low carbon economy are. Two banks were selected, considered as those that reported more advanced internal carbon pricing practices for their client portfolio, according to the 2016 CDP climate change report. These are: BNP Paribas and International Finance Corporation (IFC).

On the other hand, the **analysis of productive sector** practices for carbon risk management took place in the form of an analysis of companies that responded to the CDP Climate Change program in 2016 and have operations in Brazil to obtain an overview, as well as interviews to explore the selected cases in more depth. It is noted that, in the context of the productive sector, it was considered relevant to explore not only the policy and legal risk of carbon pricing, but also the other transitional risks – which involve considerations on technological routes, market position and reputational risk – and physical risks.

CDP Climate Change is a program led by investors that invites publicly-held companies worldwide to report information related to climate change and its connection to business strategy, climate risk identification and management processes, GHG emissions and their reduction targets, inter alia. The selection of that information source was made as the CDP disclosure system relies on the participation of more than 6,000 companies around the world, which account for 60% of global market capitalization and investors that mobilize more than US\$ 100 trillion in financial assets. For this part of the analysis, the study counted on a partnership between FEBRABAN and the CDP, which resulted in a report prepared by the CDP and used as an input for this study.

The CDP analysis considered the answers of 71 companies operating in Brazil⁶⁴ and that participated in the program in 2016, out of a total of 120 companies invited under the market capitalization criterion according to the expanded IbrX100 index. For the purposes of comparison and to allow qualitative analyses with a smaller sample size, out of the 71 companies, those that report their GHG emissions in the Public Emission Registry of the Brazil GHG Protocol Program⁶⁵ were selected, as a proxy of transparency and a first step for operation in carbon risk management. The selection of that group was based on the composition of the Bovespa Index⁶⁶ (IBOV) during the period from September to December 2016. Out of 55 listed companies, those in the service sector were excluded for having no relevant scope-1 emissions, which are direct GHG emissions produced or controlled by the organization.⁶⁷ Among the remaining 45 companies, only those recording their GHG emissions in the Public Emission Registry in the 2010-2016 period were selected for the analysis, amounting to 21 companies. Among them, only one failed to answer the 2016 CDP Climate Change, resulting in a sample of 20 companies achieved. Annex 6 provides 71 responding companies and the comparative sample of 20 companies considered in the CDP analysis, which was based on 19 of 41 questions from the 2016 Climate Change questionnaire, by addressing three key areas: strategy, targets and initiatives, and risks.

⁶⁴ Overall, 120 companies have been invited under a market capitalization criterion, in accordance with the expanded IbrX100 index.

⁶⁵ <http://registropublicodeemissoes.com.br/>

⁶⁶ http://www.bmfbovespa.com.br/pt_br/produtos/indices/indices-amplos/indice-ibovespa-ibovespa-composicao-da-carreira.htm

⁶⁷ (FGVces and WRI, Second edition)

In addition to the analyses of companies that responded to the CDP Climate Change program in 2016, interviews were carried out with representatives of companies from sectors indicated by the TCFD that had a greater possibility of suffering climate-related financial impacts, with the objective of understanding in more depth how risks associated with carbon, both physical and transitional, are or are not being incorporated into the companies' risk management process.

The selection of the interviewed companies (Annex 7) was based on IBOV composition in the period from September–December 2016, considering the four priority groups indicated by TCFD. Three of the four sectors are included in the considered sample, given that the transportation group has no listed company and was therefore not considered in interviews. Upon crossing the listed companies with the groups with a higher exposure to climate-related risk, the participation in the Emissions Trading System Simulation administered by FGVces was considered as a proxy for companies more involved with the topic of climate change. Based on these filters, companies considered by FGVces as being active in carbon risk management in terms of mitigation and adaptation were selected. Thus, representatives of Braskem, CPFL Energia, Fibria, and Vale were interviewed.

Once the companies were selected, the content to be addressed in interviews was based on publicly reported information by each of the four companies in the 2016 CDP Climate Change questionnaire and prepared according to report categories recommended by TCFD, as described in Figure 3.

In addition to the overview of how productive sector companies are preparing themselves for risks related to climate change, the study provides a first exercise prioritization of relevant topics for the four priority sectors indicated by TCFD, to be considered by financial institutions in carbon risk management in their analyses of socio-environmental risk to compose a checklist. This survey derives from documentary review and is complemented by reflections from interviews with representatives of the productive sector and internal reflections of the FGVces team.

Study limitations

Analyses carried out through interviews with the productive sector stemmed from listed companies, predominantly taking into account the availability of public information. However, there are several sectors that have no listed companies and that will be impacted by risks related to climate change, as is the case of the transportation group proposed by TCFD, which includes the automotive industry.

Methodological complexities related to the measurement, report and verification (MRV) of GHG emissions and removals are not included in this study, however the importance of such topics is recognized to advance in carbon risk management, especially in the case of the agriculture, food and forest product group, which is relevant in the context of the Brazilian economy.

The interviews only included companies that are relatively advanced in terms of carbon risk management, which is a sample that cannot be considered representative of the reality of the Brazilian productive sector. However, that sample was considered to be appropriate, considering that TCFD recommendations are sophisticated and demand a certain level of maturity in the topic to be implemented. Therefore, a sample was sought that could help in understanding if and how the companies' practices match the recommendations proposed by TCFD, without intending to generalize the obtained results for the Brazilian productive sector.

6. Results and analyses

Financial sector practices

At an international level, banks are starting to move towards implementing the internal carbon price, given that an increasing number are interested in applying carbon pricing to improve risk management and support their investment decisions. To support this process, it is essential to disclose current successful practices of policies and approaches. Two banks have stood out in this context and their experience is shared below.

BNP Paribas

BNP Paribas introduced carbon pricing in its financial decisions by integrating the carbon risk analysis with the assessment of its clients. Internal carbon price, ranging between US\$ 25 and US\$ 40/tCO₂, is defined based on three factors: the average prices reported by CDP, the social cost of carbon, and the price by which power plants are motivated to change from coal to gas. That price range is applied to the stress test on EBITDA of clients in eight industries: oil and gas, mining (coal and aluminum), power, transportation (aviation, maritime, automotive), construction, cement, chemical, and agribusiness (meat, dairy, packed food). Considering a life cycle approach for each industry, pricing is applied to different emission scopes according to their relevance, for example: for transportation, scope 3 is the most relevant; for mining, scopes 1 and 2 apply. For each sector, a benchmark of companies is made in terms of emissions to assess the carbon intensity of each of them and their resilience to the introduction of a carbon price.

This quantitative analysis is complemented by a prospective qualitative analysis to understand how each company will behave in a low-carbon economy in relation to its peers in terms of mitigation and adaptation actions. In this sense, it is recognized that the average increase of 2°C would have a great impact on bank clients and therefore it is considered relevant that companies report their actions and strategies as proposed by TCFD so that the banks have access to this information.

Thus, BNP Paribas classifies its clients according to their potential climate risk, analyzing the impacts related to the climate under a best in class view. Through this analysis, the institution tries to advise their clients on the evaluation of technological routes choices considering climate change. Quantitative and qualitative analyses of carbon risk have the same weight and are intended to be incorporated into credit risk assessments in the future, in which pricing is seen as a tool to manage the portfolio and its related carbon risks.

In terms of opportunities, BNP sees the role of banks as that of assisting their clients in the transition to a low carbon economy, considering that there are opportunities in terms of credit, for example for technologies of low carbon emission, and investment, such as green bonds and catastrophe bonds.⁶⁸

International Finance Corporation (IFC)

The International Finance Corporation (IFC), which is a part of the World Bank Group, started the implementation of internal carbon pricing via a pilot focused on project finance clients of three sectors considered high emitters: cement, chemical and thermal power. An annually increasing carbon price ranging from US\$ 30 to US\$ 80/tCO₂, based on the social cost of carbon, is applied only to emissions of scope 1 and 2 to calculate the economic rate of return. A stress test was made for existing business portfolio in the three selected sectors to understand how carbon price would impact the economic calculation.

Carbon pricing is used as an information tool to guide risk management, not as an obstacle to investment decision. As such, it is considered as a red flag to promote dialogue with clients, rather than a sole criterion for investment decision, given that projects labelled as of high carbon risk are revisited in order to consider ways to reduce emissions and increase energetic efficiency, for example. The challenge is to have access to that information right at the beginning of the project cycle, recognizing the relevance of reporting practices by companies.

⁶⁸ By representing a market of approximately US\$ 13.5 billion in 2017 (Artemis, 2017), Catastrophe Bonds or Cat Bonds are an example of securitization to create securities related to risk, which transfer a specific set of risks (generally catastrophe and natural disaster risks) from an issuer or sponsor (insurance or reinsurance company or even the State) to investors. Thus, investors take the risk of occurrence of a particular catastrophe or event in return for attractive investment rates. If the catastrophe occurs, the investors will lose the invested principal and the issuer will receive that money to cover his losses (Artemis, c2017).

The IFC believes that the carbon price currently considered in stress tests is sufficient to cause some level of impact on decisions internally, but it recognizes the difficulty in setting the price, as it depends on the economic activity developed by each company and the operation location, inter alia. The institution still lack means of quantifying the potential impacts of an average increase of 2°C in global temperature on the clients' financial results.

As its next steps, the IFC intends to expand the analysis to other high-emission sectors and to corporate debt and variable income, with the possibility of scoring companies sectorally. The bank has been questioned and is studying how to estimate its scope-3 emissions – related to invested projects – in a quick and accurate way. Also, the IFC is a part of the “Banking Sector Task Team” of the Carbon Pricing Leadership Coalition.

In terms of opportunities, the IFC considers making public its risk evaluation tool to allow its clients to manage their own risks related to carbon pricing. As regards to climate risks in general – including physical risks – the bank is working in a tool for sectorial impacts from climate change, which comprises ports, agroforestry, hydroelectric power, power generation and insurance, inter alia.

Practices of the productive sector

Outlook of Brazilian companies

In terms of the integration level of climate-related risks and opportunities into the company's practices and strategies, 79% of 71 companies that responded to the 2016 CDP Climate Change questionnaire and 100% of the 20 companies considered in the comparative sample (Annex 6) declare that climate change is integrated into their business strategy. 25% of respondents have no documented risk management processes related to climate change, while that percentage decreases to 5% when the comparative sample is considered. In general, 65% of Brazilian companies that responded to the 2016 CDP Climate Change questionnaire integrate climate risk into the company's risk management process.

The first key area, **strategy**, assesses the treatment given to climate change and the level of integration into the companies' practices and business strategy. The CDP questionnaire considers three key aspects related to the effective integration of climate change into business strategy, which include: evaluation frequency, the hierarchical level in which the matter is discussed in the corporation, and the time horizon in which risks are considered. Among the comparative sample companies, a little more than half of them (12 companies) have a maximum performance when these three aspects are analyzed.

It is also assessed how and at which levels risks are identified, whether at an organizational level as a whole or at the level of its assets. Risks assessed at the corporate level involve reputational risks, which may affect the company as a whole, while risks at asset level reflect impacts on productive and business units. Six of the companies assessed in the comparative sample reported no procedures for identification of risks at asset level given that this approach is essential for an effective management strategy, especially for companies with a pulverized operation, several units in different regions and different specificities and impacts.

The second key area, **targets and initiatives**, assesses the activities and projects focused on the GHG emissions reduction, mitigation of and adaptation to climate change. Setting targets determines the path to be followed and makes easier the engagement necessary for the effective transformation of business models in a climate change scenario. Among the 71 responding companies, 57% have some type of target for GHG emissions reduction, being the case that most of them have more than one type of target. In the comparative sample, on the other hand, 90% of respondents have some type of target and 35% of them have targets for the reduction of emission intensity.

The program considers that, in order to be significant, the targets must cover the majority of emissions and be consistent with the decarbonization level recommended by science to limit the temperature increase up to 2°C. The targets of only two of the 20 comparative sample companies meet the basic criteria of Science Based Targets, which is a joint initiative between CDP, United Nations Global Compact, World Resources Institute (WRI) and World Wildlife Fund (WWF), which aims to increase the ambition level of corporation actions as regards to climate change.

According to the CDP methodology, the best practices for the management of reduction initiatives are evidenced when the description of activity, investment return time and related emission reduction are informed, and when the activity is carried out within the same scope (scope 1, 2 or 3) of the targets established and reported by the company. However, four of the twenty evaluated companies do not meet any of these criteria, while only two of them meet them partially, thus evidencing the need for evolution of the topic maturity in which climate change influences the corporate strategies that are, in turn, translated into targets and consequently materialized in actions and results.

As regards to low-carbon products or those that prevent GHG emissions by third parties, although 52% of companies affirm that they have this type of product, in 80% of cases these products achieve no more than 10% of the research and development budget. This information leads to the conclusion that these products still do not result from a more ambitious strategy for innovation of the business model or disruptive change.

The importance of aligning the targets of emission reduction and energetic consumption with the companies' business strategy must be stressed. The correlation between the company's strategy and its targets related to climate change may substantiate the efficiency of its management by transforming core guidelines into actions and initiatives that permeate business and operational units.

Finally, the third key area, **risks**, considers the assessment of physical, regulatory or other risks⁶⁹ related to climate change, as well as their respective financial impacts and management. By evaluating the perception of several types of risks associated with climate change of 71 responding companies, it is recognized that the majority of respondents observe the risks of at least one of the categories with the potential to impact their business.

⁶⁹ Other risks related to climate change include: reputation, change in consumers' behavior, changes driven by local communities and cultural aspects, fluctuations in socioeconomic conditions, inter alia.

Among the risks caused by regulatory changes, they are most frequently generated by environmental issues in general (21%), fuel and power taxation (12%), regulatory uncertainty in renewable power (10%), and obligation of reporting GHG emissions (9%). In terms of potential impacts caused by regulatory risks, the most recurring of them is the increase of operational cost (60%). Risks caused by change in regulation are mostly direct (79%) and affect the particular operations of the companies. In 34% of replies, risk is analyzed within a time horizon of more than six years, in 30% the potential occurrence is considered high, and in 32% risk impacts are considered low.

With respect to the risks caused by changes to physical climate patterns, the most mentioned risk generator is the change in extreme rainfall and drought (22%), followed by the change to average rainfall (18%). With respect to the potential impact, the reduction and interruption of production capacity and increase of operating costs are highlighted at 41% each. With respect to the time horizon in which such risks are analyzed, the perception varies widely, with 25% of replies considering more than one year or more than six years.

CDP methodology determines whether the companies are able to describe the following aspects for each risk category: risk description, time horizon, probability, impact magnitude, financial implications (qualitative/quantitative), and description of management method. The last two aspects – financial implications and management method – are the most important factors to evaluate the performance of companies in the management of climate risks.

With respect to the regulatory risks, 13 of the 20 companies assessed in the comparative sample failed to report the resulting financial implications and five of them failed to describe the non-measurable impacts. Further, three companies provided no explanation on the management method for such risks, while another three companies provided no practical example of the management methods, by making only a description of the risk management methodology.

For physical risks, only six of the 20 companies reported the financial implications, while eight of the 14 remaining companies described non-measurable implications and six reported no financial implication derived from the physical risks. Five companies only provided the description of their management methods without any example, while three companies provided no information about their risk management methods.

Regarding the other risks, 14 of the 20 assessed companies failed to quantify the financial implications derived from the identified risks, six of which reported non-measurable implications. Five of the 20 companies provided no information related to the risk management methods, while three of them only described their methods. Among the assessed companies, 12 of them, representing a little more than 50%, provided the description of their management methods and practical examples of their performance.

In general, an assessment of the two main indicators of risk identification (financial implications and management methods) shows that more than half of the sample of 20 companies failed to provide an analysis of financial implications derived from the identified risks, resulting in a difficulty in assessing the climate risk. However, setting the price of such impacts is essential to make the decision makers aware of such risks and their possible implications. Management, in turn, is generally made in the short and medium term, while an effective risk management must take into consideration long-term actions and measures, in addition to a robust quantification and management strategy.

Finally, with respect to the internal carbon pricing, 17% of the sample use that instrument, while 18% intend to do so over the next two years and 42% have no intent to implement it. In sample B, such percentages are 20%, 35% and 45%, respectively. It is emphasized that 37 of the 63 companies that reported regulatory risks have adopted or intend to adopt no internal carbon pricing over the next two years, thus indicating a misalignment of perceptions about the relation between carbon pricing and regulatory risk.

In Box 3 below, some analysis of replies to the 2016 CDP Climate Change are highlighted by considering all 71 responding companies and the comparative sample of 20 companies.

Box 3 – Highlights of 2016 CDP Climate Change responses

Looking at the whole picture...

65% of Brazilian companies that responded to 2016 CDP Climate Change integrate climate risks into the company's risk management process.

Looking at the comparative sample...

More than **50%** of companies provided no analysis of the financial implications derived from identified risks, thus resulting in a difficulty in assessing climate risk.

58.7% of companies do not adopt or intend to adopt internal carbon pricing in the next two years, thus indicating a misalignment with the perceptions of the relation between carbon pricing and regulatory risk.

30% of companies reported no procedures to identify risks at assets level.

20% of companies meet no CDP methodology criteria related to the best practices for reduction initiative management, and **10%** partially meet such criteria, thus evidencing the need of evolution of topic maturity.

As such, the analysis of the replies to the 2016 CDP Climate Change in general indicates that:

- ✓ The climatic risk is perceived by respondents as a strategic topic, but it is also necessary to enhance its quantification and management;
- ✓ The responding companies have targets for the GHG management and are interested in developing products that will contribute to reduce emissions, however, there are still low targets aligned with the objective of limiting temperature increase by no more than 2°C;
- ✓ The companies are monitoring risks associated with climate change, however, they are more concerned with the impact of climate change on their own operations and with short and medium-term management; and
- ✓ Analysis of the financial implications from climate change on the company's results is still little considered by respondents.

Case analyses

Results of the interviews with Braskem, CPFL Energia, Fibria and Vale representatives have been systematized by considering the four pillars proposed by the framework of the Task Force on Climate-related Financial Disclosures shown in the following sequence: Governance, Strategy, Risk Management, and Metrics and Targets.

In terms of **governance** of the organizations with regard to climate-related risks and opportunities, it was noted that the interviewed companies have instances dedicated to sustainability, with their own teams and budgets. The topic of climate change moves across several areas of the companies, and is considered strategic.

Box 4. Strategies and actions of the interviewed organizations with respect to the “Governance” pillar

GOVERNANCE

Braskem:

- Matters related to climate change are proposed by the CEO and analyzed by the Strategy and Communication Committee (CEC) of the Board of Directors. The Board of Directors analyzes the approach proposed by the CEO and the recommendations of the CEC and approves the company’s strategy for climate change. The CEO, from that moment on, is responsible for the strategy implementation.
- It provides financial incentives (monetary reward) to all employees – including leaders of the plants with the **highest GHG emissions**, environment/sustainability managers, sustainable development director, vice-president of relations with investors and sustainable development, and the CEO – for management of matters related to climate change.

CPFL Energia:

- The highest level of direct responsibility for the topic is the sustainability director.
 - Climate platform with five areas: investments, carbon pricing, management indicators, advocacy and climatic risks.
 - It provides financial incentives (monetary reward) to the sustainability team for management of matters related to climate change.
-

GOVERNANCE

Fibria:

- Sustainability Committee is responsible for establishing the strategy, the Environment, Forest and Industry areas are responsible for the implementation, and the Internal Sustainability Committee is responsible for the monitoring.
- It provides financial incentives (monetary reward and non-monetary recognition) to all employees – including facilities and environment/sustainability managers – for management of matters related to climate change.

Vale:

- Matters related to climate change are under the responsibility of the Executive Board.
- It provides financial incentives (monetary reward) to all employees - including CEO, corporate executive team, business unit director, business unit, facilities and environment/sustainability managers and climate change team – to manage issues related to climate change.

Source: Interview with companies

In terms of **strategy** and financial planning of the organizations with respect to real and potential impacts of climate-related risks and opportunities on business, it was noted, among the interviewed companies, the existence of different drivers for carbon management. While mitigation has been established for longer, physical risks have also gained relevance, which is shown by the emergence of the adaptation front. Most companies consider approaching all risks categories considered by TCFD.

Box 5. Strategies and actions of the interviewed organizations with respect to the “Strategy” pillar

STRATEGY

Braskem:

- Drivers for performance in carbon risk management: great emitter (risk associated with competitiveness in a global market) and opportunity of product differential.
- They consider approaching all risks considered by the TCFD.
- Examples of risks: obligations of emissions reporting, cap-and-trade schemes, and water shortage.
- Examples of opportunities: change in consumers’ behavior, reduction of production costs by technological improvements.

CPFL Energia:

- Drivers for performance in carbon risk management: vision of competitiveness (renewable energies).
- They consider approaching all risks considered by the TCFD, which are necessary to advance in regulation (opportunities).
- Examples of risks: voluntary agreements (increase of capital costs), change to rainfall standards (interruption of operations).
- Examples of opportunities: reputation, change in consumer’s behavior.

Fibria:

- Drivers for performance in carbon risk management: mitigation – regulatory risk (pricing) and opportunity of recognition for sequestering GHG; and adaptation – physical risks (water availability, temperature).
- They consider approaching all risks considered by the TCFD.
- Examples of risks: lack of regulation for peers, change in the extremes of temperature and rainfall.
- Examples of opportunities: cap-and-trade schemes (emission compensation), reputation (leadership in topic).

Vale:

- Drivers for performance in carbon risk management: investors (CDP) and sectorial comparison (CDP report – mining).
- Focus on the physical and regulatory risks (technological and market risks have still a small visibility).
- Examples of risks: uncertainty related to new regulations, changes in rainfall patterns (damages to assets, operation interruption).
- Examples of opportunities: incentives for the use of new technologies, change to climatic patterns (expansion of agriculture areas and more transportation).

Source: Interview with companies

In terms of **risk management** involving the identification, assessment and management of climate-related risks, the interviewed companies analyze risks for businesses by considering the unforeseeable climatic conditions and they analyze adaptation plans for a short-term time horizon (three to six years), while some companies assess for more than six years.

Box 6. Strategies and actions of the interviewed organizations with respect to the “Risk Management” pillar

RISK MANAGEMENT

Braskem:

- Identification of risks and opportunities: use of the adaptation tool developed by the Business for Climate Platform (EPC-FGVces), an analysis involving other stakeholders (e.g. INPE), considering current and future scenarios (2040).
- Climate topic is a cross-section in corporate risk management (incorporated to the company's areas instead of being approached in a separate area).
- Actions in mitigation and adaptation fronts.

CPFL Energia:

- Identification of risks and opportunities considering a time horizon of three to six years.
- Expansion planning considers technological alternatives of lower risk to business and greater opportunities for low-carbon economy.
- Carbon risk management inserted in the mindset of business continuity plan.

Fibria:

- Identification of risks and opportunities through the adaptation of three IPCC climate scenarios to anticipate risks of forest productivity loss under future unforeseeable climatic conditions, by considering a time horizon of more than six years.
- Actions in mitigation and adaptation fronts.

Vale:

- Identification of risks and opportunities through an impact map based on the IPCC, by considering a time horizon of three to six years.
- Most actions are still in the scope of mitigation.

Source: Interview with companies

In terms of **metrics and targets** used to assess and manage relevant climate-related risks and opportunities, all interviewed companies have some type of target for the GHG emission reduction and use some type of internal carbon pricing to support the decision-making process.

Box 7. Strategies and actions of the interviewed organizations with respect to the “Metrics and Targets” pillar

METRICS AND TARGETS

Braskem:

- Targets for emission reduction (absolute and intensity).
- “Sustainability Index” to improve investment prioritization.
- Test the implementation of a process to analyze investments that use the virtual carbon value (internal pricing).

CPFL Energia:

- Targets for emission reduction (intensity).
- Use of internal carbon pricing to assess the exposure of the portfolio as a whole (use in modeling new businesses and new plants).

Fibria:

- Target for emissions reduction (absolute) and targets for renewable power consumption.
- Analysis of the Marginal Abatement Cost Curve to foster investment in activities of emission reduction (as the company works on a great scale, any small reduction is amplified).
- Internal carbon price: US\$ 5 for forests, US\$ 10 for industry and logistics, and US\$ 30 for new businesses.

Vale:

- Targets for emissions reduction (absolute).
- “Green Internal Rate of Return” calculation: carbon price of US\$ 22/tCO₂e for scope 1 emissions in capital projects.
- Analysis of the Marginal Abatement Cost Curve to identify more cost-effective mitigation options and prioritize projects.

Source: Interview with companies

By analyzing the results of a company that represents the paper and forest product industry (Fibria) in the TCFD agriculture, food and forest product group, it is noted that there is a great work in the adaptation front due to the direct connection of operations to the natural capital and therefore the importance of physical risks mainly associated with its own operations. The relevance of pressure by investors in this group is noted, most of which are international, probably motivated by concern with risks associated with deforestation. The time horizon in which climate-related risks and opportunities are addressed is more than six years, being aligned to the useful life of the company's assets. In relation to carbon pricing, the company understands that it may be a risk or opportunity for the sector, depending on how its rules and parameters are established.

For the company that represents the metal and mining industry (Vale) in the group of materials and construction of the TCFD, a focus on mitigation actions is noted, as that type of activity is a high GHG emission generator. For having a wide logistic system and, therefore, depending on a robust infrastructure for its operations, the company has relevant physical risks both in its own operations and its chain. For being a business-to-business company (B2B), climate management actions have shown a competitive differential more among investors than among consumers. Technological risks are not expressively managed yet.

For a company that represents the industry of chemical products (Braskem) in the group of materials and construction of the TCFD, a strong performance is noted both in the mitigation front and adaptation front, possibly due to the perception of risks and opportunities in terms of products and industrial plants, respectively. It is noted that there is a great interest in exploring both risks and opportunities with a view that the company may contribute with products that reduce GHG emissions, such as green plastic. The time horizon in which climate-related risks and opportunities are worked is more than six years. For having relevant GHG impacts both on its own operations and supply chain, its climate management actions consider both of them.

Lastly, for the company that represents the energy group (CPFL Renováveis), there is a view especially focused on opportunities instead of risks. Climate management actions are aligned with the company's strategy, such as the search for diversifying the territories where the company operates, thus "pulverizing" the risk of extreme climate events. That way, the locational diversity of operations is considered from a business continuity standpoint, and not as an isolated adaptation action. The GHG mitigation actions are considered relevant for its clients, for being a business-to-consumer company (B2C).

One of the main TCFD recommendations refers to the resilience of the organization strategy, by taking into account the different climate-related scenarios, including a scenario with an increase of 2°C in global temperature. Although some analyzed companies are considered more advanced with respect to the matter of carbon risk management, none of interviewed companies has that type of scenarios analysis.

7. Relevant sector-related questions: illustrative examples

Upon the disclosure of the TCFD recommendations, it is expected that banks will start to require more information on the financial impacts related to climate change on a company, while making greater use of existing information.⁷⁰ In addition to the general recommendations, the Task Force emphasizes the importance of considering the four productive sectors that are more exposed to climate-related risks (Energy; Transportation; Materials and Buildings; Agriculture, Food and Forest Products), and to contribute in this sense, specific recommendations (Annex 2) for such sectors in the strategy (recommendations B and C) and metrics and targets (recommendation A) pillars are made, including illustrative examples of metrics (Annex 8). In that same matter, the CDP includes in its questionnaire on climate change additional questions to energy, transportation and agriculture sectors (Annex 9).

Based on such references and trying to contribute to the socio-environmental risk analysis processes of banks, this report includes examples of relevant questions for each of the four sectors, some of which were prepared on the basis of the specificities of the Brazilian context. This is understood as a first illustrative exercise that must be deepened in discussions with the Brazilian financial sector and productive sector to advance toward the preparation of a guide containing the material questions for each sector in terms of climate-related risks and opportunities and their financial impacts.

⁷⁰ (Donovan, 2017)

Relevant sector-related questions: Energy

How much is your company expanding the participation of renewable energies in its energy matrix?

Because of the particularities of this sector's regulation in Brazil – with the National Interconnected System – in years of water crisis, when hydroelectric power generation is compromised, power reposition in the system is predominantly made by thermoelectric generation. By considering the trend of carbon pricing, carbon-intensive sources of energy, like thermoelectric plants, will have their costs increased, thus representing a risk to the sector. The risk associated with carbon pricing and non-tariff barriers is also a significant risk to oil, gas and coal groups. Thus, it is important to understand how that group is managing the transition to a low-carbon economy and if it is studying clean energy sources, like solar and wind power, which may replace fossil sources in crisis scenarios.

Does your company consider in its planning for the coming years other actions to mitigate GHG emissions, in addition to the use of renewable energies?

Reductions of the GHG emissions in the energy sector may be achieved through several measures in addition to the increased participation of renewable energies in the energy matrix. Such measures include the improvement of energy efficiency in transmission and distribution, the cut of emissions from extraction and conversion of fossil fuels and the reduction of final demand for energy. It is important to consider how the companies of that sector are exploring such alternatives in their strategies and anticipating future risks, such as the change in demand by consumers.

Does your company consider the issues of adaptation to climate change?

Transmission, storage and energy distribution networks are vulnerable to extreme climate-related events, such as strong winds, lightening, storms and high temperature, among others. More frequent period of droughts and seasonal changes in rainfall patterns will change the water availability of regions by impacting the capacity of hydroelectric power generation and eventually resulting in a power safety problem, especially in countries that, like Brazil, have a predominance of that source of clean energy in its power matrix. Water restrictions also impact the cooling of thermoelectric plants

while high water temperatures reduce the cooling efficiency. In addition, extraction, processing, transportation and storage activities related to the production of oil, gas, coal and biofuels are intensive in water use. In this context, it is important that the companies of that sector develop plans of adaptation to climate change, by surveying the future risks and opportunities as well as the actions to reduce their vulnerability to potential impacts.

Relevant sector-related questions: Transportation

Has your company considered new low-carbon technologies?

A good part of the GHG emissions in the transportation sector is due to the burning of fossil fuels. In the context of a low-carbon economy, types of transportation that depend on more efficient renewable power sources will gain space, for which it is necessary to conceive new products and look for disruptive innovations.

Does your company consider the issues of adaptation to climate change?

Climate change represents a physical risk to transportation infrastructure, including high temperatures, sea level rise, storms and extreme winds, among others. Impacts from climate change on transportation infrastructure vary according to several factors (such as location, design and time of existence) by generating consequences to regulators, owners, operators and users. In this sense, it is relevant that this sector consider adaptation actions in its planning process.

Relevant sector-related questions: Materials and Buildings

Does your company consider the climate risks in its value chain?

Some sectors of this group, such as metal and mining and chemicals, have a significant dependence on physical assets and infrastructure. In the case of mining, climate change represents a risk to its supply chain because of interruptions in transportation networks, availability of water and power resources, and health and safety of their employees in operation sites. Such risks may be increased by challenging geographies and climates in

which the mines are located. For the chemical industry, climate change represents a risk to its supply chain – very often large and complex –, which are vulnerable to interruptions caused by storms, floods, droughts and high temperatures, among other events. The real estate and construction sector, on the other hand, is capital intensive with many long-term fixed assets that depend on water and power for their operations. That way, it is important that sectors with high risks in their value chains, but not necessarily in their own operations, consider that aspect in their risk management process.

To what extent is your sector exposed to international policies and requirements related to climate change?

For industry in general, it is important to understand the commercial exposure of each sector, that is, how much each sector is exposed to international negotiations. The greater the commercial exposure, the greater the associated risk. That is because products negotiated internally in the country, such as cement, are all under the same umbrella of international rules and agreements. On the other hand, products negotiated externally are exposed to different policies and requirements from their international peers, which may result in commercial disadvantage. For example, products from a country that has established carbon pricing may be more expensive than products from countries that do not have such rules and therefore may be less competitive. The opposite is also possible: countries having more restricted rules related to the global climate may impose barriers to imports from countries that have no similar obligations, like in the case of Australian products that may have their competitiveness undermined by the launch of the national carbon market in China.⁷¹

What is the percentage of exports to countries with climate regulations?

In one side, industries of high commercial exposure may seem to be in competitive disadvantage in relation to their peers during the period of transition to a low carbon economy, in which there is not yet an alignment of rules for all sector companies. On the other side, the companies that do not manage their emissions may be subject to commercial barriers upon exporting to counties that already have climate regulations.

⁷¹ (Nogrady, 2017)

What is the capacity to pass on the costs of your product?

The risk of carbon pricing impacting businesses will depend on the elasticity of supply and demand for the good or resource. If the demand for the good is inelastic (like in case of cement, which has a high relative importance as an input for other sectors of the economy and a low capacity to be replaced by other inputs), the risk associated with pricing is minimized, as that cost tends to be widely passed on to consumers. The opposite occurs, for example, with chemical subsectors of commodities, such as petrochemical, plastic material, resin and basic organic chemicals.

Relevant sector-related questions: Agriculture, Food and Forest Products

Does your company consider scope-3 emissions?

The agriculture and food sectors have a great complexity in terms of measurement, report and verification (MRV) of their GHG emissions. The highest representation of emissions in that sector is in its scope 3, in the suppliers of large food and farming companies. Tracing the supply chain is still a methodological challenge that has a high related cost.

Does your company consider the issues of adaptation to climate change?

Although all sectors of that group are vulnerable to the physical risks related to the climate, agriculture, the packed food and meat sectors are less resilient to climate change impacts. Besides, such sectors have the particularity that many actions are, at the same time, for mitigation and adaptation, which is the case of the Integrated Crop-Livestock-Forestry systems: while contributing to reduce GHG emissions, that strategy works as an adaptation action for diversifying the production by reducing the possibility of generalized losses.

Is your company identifying the opportunity related to the Brazilian NDC target to recover and reforest 12 million hectares? If yes, what actions are being taken?

By considering the Brazilian commitment to reforesting and promoting the natural regeneration of 12 million hectares until 2030, there is, in the short term, the challenge to make such actions economically feasible, although in the long term, the environmental gain may strengthen the Brazilian competitiveness against the requirements of

international markets and lead Brazil to the position of global leader in a low-carbon economy. In addition, the economic exploration of the recovered forest may represent an opportunity as an economic source through the productive chains of its products.

Does your company consider forest carbon as an asset/opportunity?

The proposed implementation of the Brazilian NDC, which is in construction process by the Brazilian Forum on Climate Change (FBMC), proposes the pricing of forest carbon as one of its actions, involving the creation of a sole forest carbon registry and the assessment of national and international opportunities with respect to negative emissions. In addition, removals may be considered to be an important offset source in the context of an emissions trading system. As such, it is relevant that said opportunity is in the focus of the Brazilian forestry companies.

To what extent is your sector exposed to international policies and requirements related to climate change?

Most products of the sector are traded at international level. It is, therefore, important to understand their international competitiveness in a low-carbon economy scenario.

What is the percentage of exports to countries with climate regulations?

In one side, industries of high commercial exposure may seem to be in competitive disadvantage in relation to their peers during the period of transition to a low carbon economy, in which there is not yet an alignment of rules for all sector companies. On the other side, the companies that do not manage their emissions may be subject to commercial barriers upon exporting to countries that already have climate regulations.

What is the capacity to pass on the costs of your product?

Food products have a flexible demand because of their high capacity of replacement for other goods and inputs. Therefore, their capacity to pass on costs is low, thus representing a higher risk with respect to high-flexibility sectors.

8. Recommendations to financial institutions

I. Qualification and internal engagement of teams in financial institutions

By considering the importance of incorporating the TCFD recommendations and carbon pricing to banks and other financial institutions, it is necessary to capacitate the internal teams with respect to such matters. Implementation of the TCFD recommendations is still considered a challenge for financial institutions, both in terms of processes and required resources, thus, the engagement of business areas is fundamental.⁷²

II. Incorporation of climate-related aspects in risk management for credit and investment analyses

By considering the density and complexity of the TCFD recommendations, it is necessary to discuss with the financial institutions their materiality and applicability in the Brazilian context. A discussion with productive sector companies is recommended to understand and establish material information to be reported to contribute to the socio-environmental risk analysis process and the necessary adaptations of the TCFD recommendations to the Brazilian context.

III. Deepening discussions on methodologies for internal carbon pricing and stress test for their client's portfolio (and implementation of scenario analysis)

Although at client level the requirement of climate-related financial information is recommended for credit risk analyses, at portfolio level the application of stress tests is recommended to allow the banks to start to consider climate change and how its possible impacts on credit quality may affect their portfolios and capital adequacy requirements.⁷³

⁷² (CPLC, 2017b)

⁷³ (Battiston, Mandel, Monasterolo, Schutze, & Visentin, 2017)

IV. Use of tools for the simulation of potential impacts from carbon pricing on client's portfolio

Use of tools that simulate the impact of carbon pricing on assets valuation may help the financial institutions in analyses of risks associated with climate change in their financing and investment portfolios. An example of an available Brazilian tool is Invesciente,⁷⁴ which was prepared by a multidisciplinary team and may be improved according to the interests of the financial sector. At international level, there are other tools, such as the Carbon Pricing Investor Toolkit.⁷⁵

V. CPLC Banking Sector Task Team participation

At international level, the Banking Sector Task Team, which is a working group within the CPLC, has performed activities in 2017 to link the efforts about corporate disclosure and internal carbon pricing to the increasing interest in measuring and managing climate risk. In this sense, that initiative shares experiences, methodologies and challenges faced by the private sector to incorporate carbon pricing into the financial institutions' processes and implement the TCFD guidelines, thus allowing banks to learn from one another and discuss potential solutions.⁷⁶ That way, it is important that FEBRABAN participates in the group of discussions to be aligned with the development of the topic at international level.

VI. Continuity of participation in Partnership for Market Readiness Project and advocacy to establish a potential instrument for carbon pricing in Brazil

Effects of climate policies vary among companies and sectors. While it is expected that renewable energy and energy efficiency sectors increase their participation in the market, fixed assets may have their values increased or reduced, depending on the energy performance. Volatility of share prices in sectors that are important for climate policy may also increase as a result of factors such as technological innovation, competition increase and political uncertainty. Therefore, climate policies may represent a risk or an opportunity among financial players, depending on the composition of

⁷⁴ <https://invesciente.com.br/>

⁷⁵ <https://www.trucost.com/capital-markets/the-corporate-carbon-pricing-tool/>

⁷⁶ (CPLC, 2017c)

their portfolios.⁷⁷ In this sense, although the disclosure of climate-related financial information is essential for risk evaluation, a stable political scenario is necessary to harmonize the multiplicity of possible results, thus reaffirming the relevance of the participation of FEBRABAN and related banks in forums such as the PMR Project and the Emissions Trading System Simulation existing in Brazil.

VII. Intra-sector articulation with other financial players

Although this report focuses its analyses on the context of banks, it is pointed out that other segments of the financial sector – with an emphasis on insurers and reinsurers – are also impacted in several ways by climate-related risks and opportunities. In this sense, it is recommended that banks articulate with other members of the Financial System to prepare joint strategies and increase the financial sector resilience to climate change.

VIII. To deepen the study of opportunities related to carbon risk management

The clients expect that the financial sector will help them to manage their financial risks. Financial institutions that quickly adapt themselves to changes in their clients' needs have a potential to improve their profitability, stability and gains from participation in the market. Ignoring the changes to clients' needs may result in reputation and political risks and a consequent reduction of profitability and increase of volatility in returns to shareholders.⁷⁸ Opportunities involve clean technology financing, design of innovative climate-related financing mechanisms and the role of broker in an emissions trading system, among others.

⁷⁷ (Battiston, Mandel, Monasterolo, Schutze, & Visentin, 2017)

⁷⁸ (Actuaries Institute, 2016)

9. Conclusions

An increasing global trend of operation in carbon risk management is identified, in terms of both emissions mitigation and adaptation to their effect, with emphasis on the increasing adoption of pricing systems as a strategy to reduce GHG emissions and manage risks related to climate change. In this context, the financial sector plays a relevant role in the transition to a low-carbon economy, both as a driver to make the productive sector implement and disclose information on carbon risk management and as a financier of the transition to a new economy.

In terms of information disclosure, the report of GHG emissions alone is no longer sufficient to understand climate-related risks and opportunities, being necessary to require information on how much the topic is inserted in business strategy, which are the procedures for identification, measurement and management of such risks, and their targets and performance.

Companies interviewed in this study (Braskem, CPFL, Fibria and Vale) are preparing themselves to address the risks of climate change and in general are using some type of internal carbon pricing to support their decision-making process. By considering the integration of climate-related risks to the strategies of Brazilian companies that responded to the CDP Climate Change Program and the analyzed corporate practices, banks could consider promoting mechanisms to know and incorporate that information to their risk management, in conformity with the recommendations of the Task Force on Climate-related Financial Disclosures of Financial Stability Board.

The activity led by the Carbon Pricing Leadership Coalition with financial institutions shows that the banks are attentive to such trends and are starting to analyze the potential impact of carbon pricing on their portfolios. Interviews made with banks under this study reinforce that opinion. Although most of the financial institutions applying internal carbon pricing use it only for their internal operations, some of them already use that instrument as a tool for stress tests in their portfolios. Carbon pricing appears, in this context, to play the role of an information tool to guide risk management, portfolio management and its related carbon risks – rather than a sole tool to guide the investment decision.

However, there are several challenges faced by banks to measure and manage their climate-related risks and opportunities, such as: absence of a methodology to estimate scope-3 emissions with a balance between robust results and easy application; definition of material scopes to be priced for each sector; and definition of a carbon price range that impacts the management decisions. It is pointed out the importance of complementing the quantitative analysis of carbon pricing with qualitative analyses that consider the performance of companies in a future scenario by taking into account mitigation and adaptation strategies.

It is not only the coal, oil and gas sectors that represent climate-related risks. Other sectors, such as agriculture and forest, and infrastructure – relevant in the Brazilian context – also deserve special attention for their relations not only with GHG emissions, but also with effects from climate change, which may affect their operations that depend on water and energy, for example. Therefore, carbon is only one of the elements related to climate change risks, and it is necessary to consider also the other elements of natural capital.

That way, upon considering the carbon risk management in the context of financial institutions, it is important to make clear that carbon pricing is only one of the risks related to the climate, being therefore necessary that the banks also consider in their analyses the other transition risks, such as technological changes and physical risks.

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Appendix 1. Climate-related risks and opportunities and potential financial impacts

CLIMATE-RELATED RISKS	POTENTIAL FINANCIAL IMPACTS
Policy and Legal	
<ul style="list-style-type: none"> • Increased pricing of GHG emissions • Enhancement emissions-reporting obligations • Mandates on and regulation of existing products and services • Exposure to litigation 	<ul style="list-style-type: none"> • Increased operating costs (e.g., higher compliance costs, increased insurance premiums) • Write-offs, asset impairment, and early retirement of existing assets due to policy changes • Increased costs and/or reduced demand for products and services resulting from fines and judgments
Technology	
<ul style="list-style-type: none"> • Substitution of existing products and services with lower emissions options • Unsuccessful investment in new technologies • Costs to transition to lower emission technology 	<ul style="list-style-type: none"> • Write-off and early retirement of existing assets • Reduced demand for products and services • Research and development (R&D) expenditures in new and alternative technologies • Capital investments in technology development • Costs to adopt/deploy new practices and processes
Market	
<ul style="list-style-type: none"> • Changing customer behavior • Uncertainty in market signals • Increased cost of raw materials 	<ul style="list-style-type: none"> • Reduced demand for goods and services due to shift in consumer preferences • Increased production costs due to changing input prices (e.g., energy, water) and output requirements (e.g., waste treatment) • Abrupt and unexpected shifts in energy costs • Change in revenue mix and sources, resulting in decreased revenues • Re-pricing of assets (e.g., fossil fuel reserves, land valuations, securities valuations)
Reputation	
<ul style="list-style-type: none"> • Shifts in consumer preferences • Stigmatization of sector • Increased stakeholder concern or negative stakeholder feedback 	<ul style="list-style-type: none"> • Reduced revenue from decreased demand for goods/services • Reduced revenue from decreased production capacity (e.g., delayed planning approvals, supply chain interruption) • Reduced revenue from negative impacts on workforce management and planning (e.g., employee attraction and retention) • Reduction in capital availability
Acute	
<ul style="list-style-type: none"> • Increased severity of extreme weather events such as cyclones and floods 	<ul style="list-style-type: none"> • Reduced revenue from decreased production capacity (e.g., transportat difficulties, supply chain interruptions) • Reduced revenue and higher costs from negative impacts on workforce (e.g., health, safety, absenteeism)
Chronic	
<ul style="list-style-type: none"> • Changes in precipitation patterns and extreme variability in weather patterns • Rising mean temperatures • Rising sea levels 	<ul style="list-style-type: none"> • Write-offs and early retirement of existing assets (e.g., damage to property and assets in “high-risk” locations) • Increased operating costs (e.g., inadequate water supply for hydroelectric plants or to cool nuclear and fossil fuel plants) • Increased capital costs (e.g., damages to facilities) • Reduced revenues from lower sales/output • Increased insurance premiums and potential for reduced availability of insurance on assets in “high-risk” locations

Source: (TCFD, 2017)

CLIMATE-RELATED OPPORTUNITIES	POTENTIAL FINANCIAL IMPACTS
Resource Efficiency	
<ul style="list-style-type: none"> • Use of more efficient modes of transport • Use of more efficient production and distribution processes • Use of recycling • Move to more efficient buildings • Reduced water usage and consumption 	<ul style="list-style-type: none"> • Reduced operating costs (e.g., through efficiency gains and cost reductions) • Increased production capacity, resulting in increased revenues • Increased value of fixed assets (e.g., highly rated energy-efficient buildings) • Benefits to workforce management and planning (e.g., improved health and safety, employee satisfaction) resulting in lower costs
Energy Source	
<ul style="list-style-type: none"> • Use of lower-emission sources of energy • Use of supportive policy incentives • Use of new technologies • Participation in carbon market • Shift toward decentralized energy generation 	<ul style="list-style-type: none"> • Reduced operational costs (e.g., through use of lowest cost abatement) • Reduced exposure to future fossil fuel price increases • Reduced exposure to GHG emissions and therefore less sensitivity to changes in cost of carbon • Returns on investment in low-emission technology • Increased capital availability (e.g., as more investors favor lower-emissions producers) • Reputational benefits resulting in increased demand for goods/services
Products and Services	
<ul style="list-style-type: none"> • Development and/or expansion of lowemission goods and services • Development of climate adaptation and insurance risk solutions • Development of new products or services through R&D and innovation • Ability to diversify business activities • Shift in consumer preferences 	<ul style="list-style-type: none"> • Increased revenue through demand for lower emissions products and services • Increased revenue through new solutions to adaptation needs (e.g., insurance risk transfer products and services) • Better competitive position to reflect shifting consumer preferences, resulting in increased revenues
Markets	
<ul style="list-style-type: none"> • Access to new markets • Use of public-sector incentives • Access to new assets and locations needing insurance coverage 	<ul style="list-style-type: none"> • Increased revenues through access to new and emerging markets (e.g., partnerships with governments, development banks) • Increased diversification of financial assets (e.g., green bonds and infrastructure)
Resilience	
<ul style="list-style-type: none"> • Participation in renewable energy programs and adoption of energy-efficiency measures • Resource substitutes/diversification 	<ul style="list-style-type: none"> • Increased market valuation through resilience planning (e.g., infrastructure, land, buildings) • Increased reliability of supply chain and ability to operate under various conditions • Increased revenue through new products and services related to ensuring resiliency

Source: (TCFD, 2017)

Appendix 2 - Sector-specific recommendations of the Task Force on Climate-related Financial Disclosures

GOVERNANCE Disclose the organization's governance around climate-related risks and opportunities.	
<p>Recommended Disclosure a) Describe the board's oversight of climate-related risks and opportunities.</p>	<p>Guidance for all sectors</p> <p>In describing the board's oversight of climate-related issues, organizations should consider including a discussion of the following:</p> <ul style="list-style-type: none"> • Processes and frequency by which the board and/or board committees (e.g., audit, risk, or other committees) are informed about climate-related issues, • Whether the board and/or board committees consider climate-related issues when reviewing and guiding strategy, major plans of action, risk management policies, annual budgets, and business plans as well as setting the organization's performance objectives, monitoring implementation and performance, and overseeing major capital expenditures, acquisitions and divestitures, and • How the board monitors and oversees progress against goals and targets for addressing climate-related issues.
<p>Recommended Disclosure b) Describe management's role in assessing and managing climate-related risks and opportunities.</p>	<p>Guidance for all sectors</p> <p>In describing the management's role related to the assessment and management of climate-related issues, organizations should consider including the following information:</p> <ul style="list-style-type: none"> • Whether the organization has assigned climate-related responsibilities to management-level positions or committees; and, if so, whether such management positions or committees report to the board or a committee of the board and whether those responsibilities include assessing and/or managing climate-related issues, • A description of the associated organizational structure(s), • Processes by which management is informed about climate-related issues, and • How management (through specific positions and/or management committees) monitors climate-related issues.

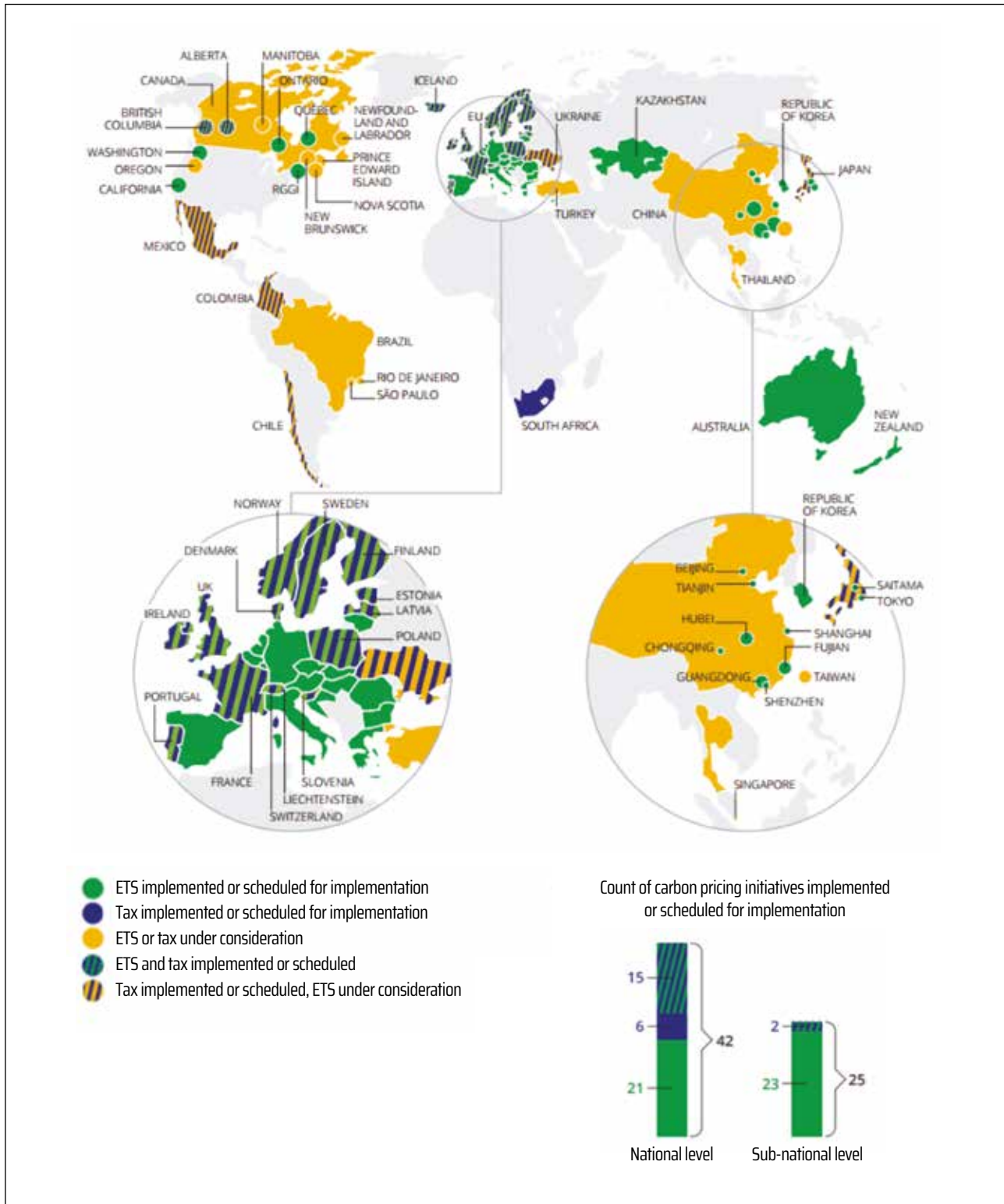
STRATEGY Disclose the actual and potential impacts of climate-related risks and opportunities on the organization’s businesses, strategy, and financial planning where such information is material.		
Recommended Disclosure a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long term.	Guidance for all sectors Organizations should provide the following information: <ul style="list-style-type: none"> • A description of what they considered to be relevant short-, medium-, and long-term time horizons, taking into consideration the useful life of the organization’s assets or infrastructure and the fact climate-related issues often manifest themselves over the medium and longer terms, • A description of the specific climate-related issues potentially arising in each time horizon (short, medium, and long term), that could have a material financial impact on the organization, and • A description of the process(es) used to determine which risks and opportunities could have a material financial impact on the organization. Organizations should consider providing a description of their risks and opportunities by sector and/or geography, as appropriate. In describing climate-related issues, organizations should refer to Tables A1 and A2 (pages 72 and 73 of the report).	
Recommended Disclosure b) Describe the impact of climate-related risks and opportunities on the organization’s businesses, strategy, and financial planning.	Guidance for all sectors Building on recommended disclosure (a), organizations should discuss how identified climate-related issues have affected their businesses, strategy, and financial planning. Organizations should consider including the impact on their businesses and strategy in the following areas: <ul style="list-style-type: none"> • Products and services • Supply chain and/or value chain • Adaptation and mitigation activities • Investment in research and development • Operations (including types of operations and location of facilities) Organizations should describe how climate-related issues serve as an input to their financial planning process, the time period(s) used, and how these risks and opportunities are prioritized. Organization’s disclosures should reflect a holistic picture of the interdependencies among the factors that affect their ability to create value over time. Organizations should also consider including in their disclosures the impact on financial planning in the following areas: <ul style="list-style-type: none"> • Operating costs and revenues • Capital expenditures and capital allocation • Acquisitions or divestments • Access to capital If climate-related scenarios were used to inform the organization’s strategy and financial planning, such scenarios should be described.	Supplemental guidance for non-financial groups Organizations should consider discussing how climate-related risks and opportunities are integrated into their (1) current decision making and (2) strategy formulation, including planning assumptions and objectives around climate change mitigation, adaptation, or opportunities such as: <ul style="list-style-type: none"> • Research and development (R&D) and adoption of new technology. • Existing and committed future activities such as investments, restructuring, write-downs, or impairment of assets. • Critical planning assumptions around legacy assets, for example, strategies to lower carbon-, energy-, and/or water-intensive operations. • How GHG emissions, energy, and water issues, if applicable, are considered in capital planning and allocation; this could include a discussion of major acquisitions and divestments, joint-ventures, and investments in technology, innovation, and new business areas in light of changing climate-related risk and opportunities. • The organization’s flexibility in positioning/repositioning capital to address emerging climate-related risks and opportunities.

STRATEGY Disclose the actual and potential impacts of climate-related risks and opportunities on the organization’s businesses, strategy, and financial planning where such information is material.		
Recommended Disclosure c) Describe the resilience of the organization’s strategy, taking into consideration different climate-related scenarios, including a 20C or lower scenario.	Guidance for all sectors Organizations should describe how resilient their strategies are to climate-related risks and opportunities, taking into consideration a transition to a lower-carbon economy consistent with a 2°C or lower scenario and, where relevant to the organization, scenarios consistent with increased physical climate-related risks. Organizations should consider discussing: <ul style="list-style-type: none"> • Where they believe their strategies may be affected by climate-related risks and opportunities; • How their strategies might change to address such potential risks and opportunities; and • The climate-related scenarios and associated time horizon(s) considered. Refer to Section D in the Task Force’s report for information on applying scenarios to forward-looking analysis.	Supplemental guidance for non-financial groups Organizations with more than one billion U.S. dollar equivalent (USDE) in annual revenue should consider conducting more robust scenario analysis to assess the resilience of their strategies against a range of climate-related scenarios, including a 20C or lower scenario and, where relevant to the organization, scenarios consistent with increased physical climate-related risks. Organizations should consider discussing the implications of different policy assumptions, macro-economic trends, energy pathways, and technology assumptions used in publicly available climate-related scenarios to assess the resilience of their strategies. For the climate-related scenarios used, organizations should consider providing information on the following factors to allow investors and others to understand how conclusions were drawn from scenario analysis: <ul style="list-style-type: none"> • Critical input parameters, assumptions, and analytical choices for climate-related scenarios used, in particularly as they relate to key areas such as policy assumptions, energy deployment pathways, technology pathways, and related time assumptions. • Potential qualitative or quantitative financial implications of the climate-related scenarios, if any.

RISK MANAGEMENT Disclose how the organization identifies, assesses, and manages climate-related risks.	
<p>Recommended Disclosure a) Describe the organization’s processes for identifying and assessing climate-related risks.</p>	<p>Guidance for all sectors</p> <p>Organizations should describe their risk management processes for identifying and assessing climate-related risks. An important aspect of this description is how organizations determine the relative significance of climate-related risks in relation to other risks.</p> <p>Organizations should describe whether they consider existing and emerging regulatory requirements related to climate change (e.g., limits on emissions) as well as other relevant factors considered.</p> <p>Organizations should also consider disclosing the following:</p> <ul style="list-style-type: none"> • Processes for assessing the potential size and scope of identified climate-related risks and • Definitions of risk terminology used or references to existing risk classification frameworks used.
<p>Recommended Disclosure b) Describe the organization’s processes for managing climate-related risks.</p>	<p>Guidance for all sectors</p> <p>Organizations should describe their processes for managing climate-related risks, including how they make decisions to mitigate, transfer, accept, or control those risks. In addition, organizations should describe their processes for prioritizing climate-related risks, including how materiality determinations are made within their organization.</p> <p>In describing their processes for managing climate-related risks, organizations should address the risks included in Tables A1 and A2 of the report, on pages 72 and 73, as appropriate.</p>
<p>Recommended Disclosure c) Describe how the processes for identifying, assessing and managing climate-related risks are integrated into the organization’s overall risk management.</p>	<p>Guidance for all sectors</p> <p>Organizations should describe how their processes for identifying, assessing, and managing climate-related risks are integrated into their overall risk management.</p>

METRICS AND TARGETS Disclose the metrics and targets used to assess and manage relevant climate-related risks and opportunities where such information is material.		
<p>Recommended Disclosure a) Disclose the metrics used by the organization to assess climate-related risks and opportunities in line with its strategy and risk management process.</p>	<p>Guidance for all sectors</p> <p>Organizations should provide the key metrics used to measure and manage climate-related risks and opportunities as described in Tables A1 and A2 (pages 72 and 73 of the report). Organizations should consider including metrics on climate-related risks associated with water, energy, land use, and waste management where relevant and applicable.</p> <p>Where climate-related issues are material, organizations should consider describing whether and how related performance metrics are incorporated into remuneration policies.</p> <p>Where relevant, organizations should provide their internal carbon price as well as climate-related opportunity metrics such as revenue from products and services designed for a lower-carbon economy.</p> <p>Metrics should be provided for historical periods to allow for trend analysis. In addition, where not apparent, organizations should provide a description of the methodologies used to calculate or estimate climate-related metrics.</p>	<p>Supplemental guidance for non-financial groups</p> <p>For all relevant metrics, organizations should consider providing historical trends and forward-looking projections (by relevant country and/or jurisdiction, business line, or asset type). Organizations should also consider disclosing metrics that support their scenario analysis and strategic planning process and that are used to monitor the organization's business environment from a strategic and risk management perspective.</p> <p>Organizations should consider providing key metrics related to GHG emissions, energy, water, land use, and, if relevant, investments in climate adaptation and mitigation that address potential financial aspects of shifting demand, expenditures, asset valuation, and cost of financing. Illustrative examples of metrics for each of the four non-financial groups are provided in the tables listed below:</p> <ul style="list-style-type: none"> • Energy Group: Table 3 (p. 54-55) • Transportation Group: Table 4 (p. 57-58) • Material and Buildings Group: Table 5 (p. 60-61) • Agriculture, Food, and Forest Group: Table 6 (p. 64-65)
<p>Recommended Disclosure b) Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 greenhouse gas (GHG) emissions, and the related risks.</p>	<p>Guidance for all sectors</p> <p>Organizations should provide their Scope 1 and Scope 2 GHG emissions and, if appropriate, Scope 3 GHG emissions and the related risks.</p> <p>GHG emissions should be calculated in line with the GHG Protocol methodology to allow for aggregation and comparability across organizations and jurisdictions. As appropriate, organizations should consider providing related, generally accepted industry-specific GHG efficiency ratios.</p> <p>GHG emissions and associated metrics should be provided for historical periods to allow for trend analysis. In addition, where not apparent, organizations should provide a description of the methodologies used to calculate or estimate the metrics.</p>	
<p>Recommended Disclosure c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.</p>	<p>Guidance for all sectors</p> <p>Organizations should describe their key climate-related targets such as those related to GHG emissions, water usage, energy usage, etc., in line with anticipated regulatory requirements or market constraints or other goals. Other goals may include efficiency or financial goals, financial loss tolerances, gas avoided GHG emissions through the entire product life cycle, or net revenue goals for products and services designed for a lower-carbon economy.</p> <p>In describing their targets, organizations should consider including the following:</p> <ul style="list-style-type: none"> • Whether the target is absolute or intensity-based, • Time frames over which the target applies, • Base year from which progress is measured, and • Key performance indicators used to assess progress against targets. <p>Where not apparent, organizations should provide a description of the methodologies used to calculate targets and measures.</p>	

Appendix 3. Map of regional, national and sub-national carbon pricing initiatives.



Source: (World Bank Group & Ecofys, 2017)

Appendix 4. Prices adopted in carbon pricing initiatives

CARBON PRICE (IN US\$/TCO ₂ E)
Less than 1: Carbon tax in Mexico, Poland and Ukraine
1: Chongqing Emissions Trading System (ETS) Pilot
2: ETS Pilot in Hubel, Guangdong and Tianjin; carbon tax in Estonia
3: Regional Greenhouse Gas Initiative (RGGI); carbon tax in Norway, Mexico and Japan
5: Carbon tax in Colombia, Chile and Latvia; ETS Pilot in Shenzhen and Fujian and ETS in European Union (EU ETS)
6: ETS in Switzerland and ETS Pilot in Shanghai
7: Carbon tax in Portugal
8: ETS Pilot in Beijing
11: Carbon tax in Iceland
12: ETS in New Zealand
13: ETS in Saitama, Cap-and-Trade (CaT) Program in Tokyo
14: CaT in Quebec, California and Ontario
15: Carbon tax in Alberta
18: Carbon tax in Slovenia
21: Carbon tax in Ireland
22: Carbon floor price in United Kingdom
23: Specified Gas Emitters Regulation (SGER) in Alberta; carbon tax in British Columbia
25: Carbon tax in Denmark
33: Carbon tax in France
52: Carbon tax in Norway
62: Carbon tax in Finland (other fossil fuels)
66: Carbon tax in Finland (liquid transportation fuels)
84: Carbon tax in Switzerland, carbon tax in Liechtenstein
126: Carbon tax in Sweden

Source: Prepared by the authors, based on data from (World Bank Group & Ecofys, 2017)

Appendix 5. Companies participating in the Emissions Trading System Simulation in Brazil in 2017



Source: (FGVces, 2017b)

Appendix 6. Companies that responded to the 2016 CDP Climate Change and comparative sample considered in the CDP analyses

71 companies that responded to the 2016 CDP Climate Change

- | | |
|---|--|
| ✓ AES Tietê S/A | ✓ Emflora |
| ✓ B2W Companhia Global do Varejo | ✓ Fibria Celulose S/A |
| ✓ Banco Bradesco S/A | ✓ Fleury S/A |
| ✓ Banco do Brasil S/A | ✓ Gerdau S/A |
| ✓ Banco Santander Brasil | ✓ Grupo BTG Pactual |
| ✓ BM&FBOVESPA | ✓ Itaú Unibanco Holding S/A |
| ✓ Braskem S/A | ✓ Itaúsa Investimentos Itaú S/A |
| ✓ BRF S/A | ✓ JBS S/A |
| ✓ BRMALLS Participações | ✓ Klabin S/A |
| ✓ Centrais Elétricas Brasileiras S/A (Eletrobras) | ✓ Kroton Educacional S/A |
| ✓ Centrais Elétricas de Santa Catarina S/A - Celesc | ✓ Light S/A |
| ✓ Central Nacional Unimed | ✓ Linx S/A |
| ✓ Cetip S/A - Mercado Organizados | ✓ Lojas Americanas S/A |
| ✓ Cia. Energética de São Paulo S/A - Cesp | ✓ Lojas Renner S/A |
| ✓ Cia Energética do Rio Grande Norte - Cosern | ✓ Marfrig Global Foods S/A |
| ✓ Cia. Paranaense de Energia - Copel | ✓ Minerva Foods |
| ✓ Cia. Saneamento de Minas Gerais - Copasa | ✓ MRV Engenharia e Participações |
| ✓ Cia. Brasileira de Distribuição (CBD) - Grupo Pão de Açúcar | ✓ Natura Cosméticos S/A |
| ✓ Cia. Siderúrgica Nacional - CSN | ✓ Newage Indústria e Comércio de Bebidas |
| ✓ Cielo S/A | ✓ Odontoprev S/A |
| ✓ Cia. de Concessões Rodoviárias - CCR | ✓ Oi S/A |
| ✓ Cia. de Eletricidade do Estado da Bahia - Coelba | ✓ Petróleo Brasileiro S/A - Petrobras |
| ✓ Cia. Energética Minas Gerais - Cemig | ✓ Porto Seguro S/A |
| ✓ Correias Mercúrio S/A Ind. e Com. | ✓ QGEP Participações S/A |
| ✓ CPFL Energia S/A | ✓ Qualicorp S/A |
| ✓ Cyrela Brazil Realty S/A Empreendimentos e Participações | ✓ Raia Drogasil S/A |
| ✓ Duratex S/A | ✓ Raízen |
| ✓ Ecorodovias Infraestrutura e Logística S/A | ✓ Rio Paranapanema Energia S/A |
| ✓ Edenred Brasil | ✓ SLC Agrícola S/A |
| ✓ EDP - Energias do Brasil S/A | ✓ Smiles S/A |
| ✓ Eletropaulo Metropolitana Eletricidade de São Paulo S/A | ✓ Tim Participações S/A |
| ✓ Embraer S/A | ✓ Triunfo |
| | ✓ Tupy S/A |
| | ✓ Ultrapar Participações S/A |
| | ✓ Vale |
| | ✓ Valid Soluções S/A |
| | ✓ Via Varejo |
| | ✓ Votorantim Cimentos |
| | ✓ Weg S/A |

Comparative sample of 20 companies

- ✓ Braskem S/A
- ✓ BRF S/A
- ✓ Cia. Paranaense de Energia - Copel
- ✓ Cia. Brasileira de Distribuição (CBD) Grupo Pão de Açúcar
- ✓ Cia. Siderúrgica Nacional - CSN
- ✓ Cia. de Concessões Rodoviárias - CCR
- ✓ CPFL Energia S/A
- ✓ Ecorodovias Infraestrutura e Logística S/A
- ✓ Embraer S/A
- ✓ Fibria Celulose S/A
- ✓ JBS S/A
- ✓ Klabin S/A
- ✓ Lojas Americanas S/A
- ✓ Lojas Renner S/A
- ✓ Marfrig Global Foods S/A
- ✓ MRV Engenharia e Participações
- ✓ Natura Cosméticos S/A
- ✓ Petróleo Brasileiro S/A - Petrobras
- ✓ Ultrapar Participações S/A
- ✓ Vale

Source: (CDP, 2017)

Appendix 7. Sample considered for selection of companies to be interviewed

Company	Bovespa Index Rating	Priority sectors: Task Force on Climate-related Financial Disclosure	Participation in the Emissions Trading System Simulation in 2017
Braskem	Basic Materials/ Chemicals	X	X
BRF	Non-Basic Consumption/Processed Food	X	
CCR	Industrial/Transportation Assets		
Companhia Siderúrgica Nacional	Basic Materials/ Steelmaking, Metallurgy	X	X
Copel	Public Utility/Electric Power	X	X
CPFL Energia	Public Utility/Electric Power	X	X
Ecorodovias	Industrial/Transportation Assets		
Embraer	Industrial Goods/ Transportation Materials		
Fibria	Basic Materials/Wood and Paper	X	X
JBS	Non-Basic Consumption /Processed Food	X	
Klabin	Basic Materials/Wood and Paper	X	X
Lojas Americanas	Cyclic Consumption/Commerce		X
Lojas Renner	Cyclic Consumption/Commerce		
Marfrig	Non-Basic Consumption/Processed Food	X	
MRV	Cyclic Consumption/Civil Construction	X	X
Natura	Non-Cyclic Consumption/ Personal Use and Cleaning Products		
Grupo Pão de Açúcar	Non-Cyclical Consumption/ Commerce and Distribution		
Petrobras	Oil, Gas and Biofuels	X	X
Suzano Papel e Celulose	Basic Materials/ Wood and Paper	X	X
Ultrapar	Oil, Gas and Biofuels	X	
Vale	Basic Materials/Mining	X	X

Source: Prepared by the authors

Appendix 8. Illustrative examples of metrics for the four sectorial groups of the Task Force on Climate-related Financial Disclosures

Metrics for the Energy Group – Illustrative examples

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Revenues	GHG emissions	Estimated Scope 3 emissions, including methodologies and emission factors used	MT of CO ₂ e	GRI: 305-3: CDP: EU4.3	(Relatively) high carbon emissions in the value chain may accelerate development of alternative technologies in a low-carbon economy. The level of emissions informs vulnerability to a significant decrease in future earning capacity.	All
Revenues	Risk Adaptation & Mitigation	Revenues/savings from investments in low-carbon alternatives (e.g., R&D, equipment, products or services)	Local currency	CDP: CC3.2, 3.3, CC6.1 SASB: NR0103-14	New products and revenue streams from climate-related products and services and the return on investments of CapEx projects that create operational efficiencies.	All
Expenditures	GHG emissions	Describe current carbon price or range of prices used	Local currency	CDP: CC2.2 SASB: NR0101-22, NR0201-16	Internal carbon prices used, affecting the assessment of an organization's key assets, provide investors with a proper understanding of the reasonableness of assumptions made as input for their risk assessment.	All

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Expenditures	Risk Adaptation & Mitigation	Expenditures (OpEx) for low-carbon alternatives (e.g., R&D, equipment, products, or services)	Local currency	GRI: G4-OG2 CDP: EU4.3	Expenditures for new technologies are needed to manage transition risk. The level of expenditures provides an indication of the level to which future earning capacity of core business might be affected.	All
Expenditures	Risk Adaptation & Mitigation	Proportion of capital allocation to long-lived assets versus short-term assets	Percentage	N/A	Impacts of climate change are subject to uncertainty in terms of extent and timing. Understanding the allocation to long-versus short-lived assets informs the potential of an organization to adapt to emerging climate-related risks and opportunities.	All
Expenditures	Water	Percent water withdrawn in regions with high or extremely high water stress	Percentage	SASB: IF0101-06	Water stress can result in increased cost of supply, impacts to operations, and increased regulation/reduced access to water withdrawal. The percent withdrawn in high water-stress areas informs the risk of significant costs or limitations to production capacity.	All

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Expenditures	GHG emissions	Amount of gross global Scope 1 emissions from: (1) combustion, (2) flared hydrocarbons, (3) process emissions, (4) directly vented releases, and (5) emissions/ leaks	MTCO ₂ e	SASB: NR0101-01	Relatively significant Scope 1 emissions are expected to drive regulations (including carbon prices) that require lower emissions from products. This can result in a significant decrease in future earning capacity.	Oil and gas
Expenditures	Energy/ Fuel	Indicative costs of supply for current and committed future projects (e.g., through a cost curve or indicative price range. This could be broken down by product, asset, or geography)	Local currency	CDP: CC3.3	Cost of supply is important because in a market with falling demand, low-cost products will continue to be brought to market. Understanding the cost of supply informs investors about portfolio vulnerability and thus earning capacity.	Oil and gas, Coal
Assets	Water	Assets committed in regions with high or extremely high baseline water stress	Number of assets, value, percentage of total assets	SASB: IF0101-06	Water stress can result in interruptions to or limitations on production capacity or early curtailment of operating facilities. The value of assets in high water-stress areas informs the potential implications for asset valuation.	All

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Assets	Risk Adaptation & Mitigation	Investment (CapEx) in low-carbon alternatives (e.g., capital equipment or assets)	Local currency	GRI: G4-OG2 CDP: EU4.3	Investments in new technologies are needed to manage transition risk. The level of investment provides an indication of the level the which future earning capacity of core business might be affected.	All
Assets	GHG emissions	A breakdown of reserves by type and an indication of associated emission factors to provide insight into potential future emissions	Amount of reserves	SASB: NR0101-23	Transition to a low-carbon economy may affect the value of reserves or long-lived assets. Providing insight into potential future emissions can help to inform investors about the potential impacts of regulatory measures and demand changes on earning capacity.	Oil and gas, Coal
			MT of CO ₂ e per unit of reserves			Oil and gas, Coal
Capital	Risk Adaptation & Mitigation	Capital payback periods or return on capital deployed	Years, percentage return on investment	CDP: CC3.3	Impacts of climate change are subject to uncertainty in terms of extent and timing. Understanding the capital payback periods or return on capital deployed informs the vulnerability of the organization to emerging climate-related risks and opportunities and the flexibility to continue the current technology portfolio at lower financial returns in a transition period to low-carbon technologies.	All

Metrics for the Transportation Group – Illustrative examples

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Revenues	Energy/ Fuel	Sales-weighted average fleet fuel economy, by region and weight/number of people transported	Miles per gallon (MPG), L/Km, gCO ₂ e/Km, transported Kg	SASB: TR0101-09	Fuel costs and associated emissions are high-priority issues for transportation companies. Understanding how an organization is managing a transition to more efficient equipment will provide insight into potential cost and regulatory impacts.	All
Revenues	Risk Adaptation & Mitigation	Revenues/ savings from investments in low-carbon alternatives (e.g., R&D, equipment, products or services)	Local currency	CDP: CC3.2, 3.3, CC6.1 SASB: TR0102-4	New products and revenues streams from climate-related products and services and the return on investments of CapEx projects that create operational efficiencies.	All
Revenues	Risk Adaptation & Mitigation	Vehicle sales (historical, current and projected) by category (e.g., gas vehicles, diesel vehicles, battery electric vehicles, plug-in hybrid electric vehicles, alternative-powered vehicles (LPG, CNG, fuel cells, compressed air)	Number of vehicles sold, value of vehicles sold	SASB: TR0101-10	New technologies are needed to manage transition risk, and demand will grow for lower-carbon product alternatives. Organizations with stronger offerings of low-carbon alternative products in their core business will be better positioned for success in the low carbon economy.	Automobiles

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Revenues	Risk Adaptation & Mitigation	Energy Efficiency Design Index (EEDI) for new ships	Grams of CO ₂ e per ton of nautical mile	SASB: TR0301-05	Per the International Maritime Organization (IMO), all ships built since January 2013 should be compliant with EEDI (Energy Efficiency Design Index) efficiency standards. A larger percentage of EEDI equipment within an organization's fleet (i.e., lower emissions-intensity fleet overall) would indicate better positioning for transition to a low-carbon economy where efficiency regulations could financially affect organizations.	Maritime
Expenditures	Risk Adaptation & Mitigation	Expenditures (OpEx) for R&D for low-carbon transportation equipment or transportation services	Local currency	SASB: TR0201-F (Age of fleet)	Expenditures for new technologies are needed to manage transition risk. The level of expenditures provides an indication of the level to which future earning capacity of core business might be affected.	All
Expenditures	Energy/ Fuel	Total fuel consumed and percent renewable for road, airlines, marine, rail	GJ, percentage	SASB: TR0201,2-03, TR0301-03, TR0401-03	In the transition to a low-carbon economy, fossil fuels will phase out whereas renewable energy will phase in. The percentage of these energy sources embedded in current assets informs the level to which future earning capacity of core business might be affected or asset value impaired.	All

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Expenditures	GHG emissions	Road vehicles – Geographic breakdown of GHG emissions: emissions and/or emission intensity of products for key geographies against regulatory requirements/targets	MT of CO ₂ e or CO ₂ e/km	CDP: AU2.3	Part of transition risk is the potential implementation of product-efficiency regulations by geography. It is important to understand how organizations are operating within these geographies and the potential exposure/impact of noncompliance.	Truckling, Automobiles
Assets	GHG emissions	Life cycle reporting of GHG emissions of Transportation products (air, ship, rail, truck, auto)	MT of CO ₂ e	SASB: TR0101-01/ 02/03, TR0102-02/05/06	How an organization manages its product life cycle emissions and utilization of raw materials will provide insight into the organization's ability to adapt to a low-carbon economy.	All
Assets	Risk Adaptation & Mitigation	Investments (CapEx) in low-carbon transportation equipment or transportation services	Local currency	SASB: TR0201-F (Age of fleet)	Investments in new technologies are needed to manage transition risk. The level of investment provides an indication at the level to which future earning capacity of core business might be affected.	All

Metrics for the Material and Buildings Group – Illustrative examples

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Revenues	Risk Adaptation & Mitigation	Revenues/ savings from investments in low-carbon alternatives (e.g., R&D, equipment, products or services)	Local currency	CDP: CC3.2, 3.3, CC6.1 SASB: IF0403- 1	New products and revenue streams from climate-related products and services and the return on investments of CapEx projects that create operational efficiencies.	All
Expenditures	Risk Adaptation & Mitigation	Expenditures (OpEx) for low-carbon alternatives (e.g., R&D, technology, products, or services)	Local currency	GRI 302-5	Expenditures for new technologies are needed to manage transition risk. The level of expenditures provides an indication of the level to which the future earning capacity of the core business might be affected.	All
Expenditures	Energy/ Fuel	Total energy consumed, broken down by source (e.g., purchased electricity and renewable sources)	GJ	SASB: IF0402- 02 GRI: 302-1	The metals and mining industries are energy- and emission-intensive industries. Buildings also account for a large portion of energy and fuel consumption, particularly in relation to heating. Understanding the levels of energy consumption by source provides an indication of the potential impact of regulatory measures in relation to the use of certain energy sources as well as the transition risks in a low-carbon economy scenario.	All
Expenditures	Energy/ Fuel	Total fuel consumed – percentage from coal, natural gas, oil, and renewable sources	GJ	SASB: NR0302-04	The metals and mining industries are energy- and emission-intensive industries. Buildings also account for a large portion of energy and fuel consumption, particularly in relation to heating. Understanding the levels of energy consumption by source provides an indication of the potential impact of regulatory measures in relation to the use of certain energy sources as well as the transition risks in a low-carbon economy scenario.	All

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Expenditures	Energy/ Fuel	Total energy intensity – by tons of product, amount of sales, number of products depending on informational value	GJ	GRI 302-3	In the transition to a low-carbon economy, the energy-efficiency levels achieved in production provide investors with an indication of the vulnerability of the product portfolio to transition risk and thus earning capacity.	All
Expenditures	Energy/ Fuel	Building energy intensity (by occupants or square area)	GJ	SASB: IF0402-02; GRI: G4- CRE1; GRESB: Q25.2	In the transition to a low-carbon economy, the energy efficiency of properties provides investors with an indication of the vulnerability of the portfolio to transition risk and thus earning capacity of real estate portfolios.	Real estate
Expenditures	Water	Percent of fresh water withdrawn in regions with high or extremely high baseline water stress	Percentage	SASB: NR0401-05	Water stress can result in increased cost of supply, factual inability to produce and/ or legislation to regulate water withdrawn for production. The percent withdrawn in high water-stress areas informs the risk of significant costs or limitations to production capacity.	All

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Expenditures	Water	Building water intensity (by occupants or square area)	Cubic meters	GRI: G4-CRE2; GRESB: Q27.2	Water stress can result in increased cost of supply, factual inability to deliver water to real estate tenants, and/or legislation to regulate water withdrawn for consumption. The building water intensity informs the (transition) risk of significant costs or limitations to this service capacity.	Real estate
Expenditures	GHG emissions	GHG emissions intensity from buildings (by occupants or square area) and from new construction and redevelopment	GJ	GRI: G4-CRE3/ CRE4	In the transition to a low-carbon economy, the carbon efficiency of the properties provides investors with an indication of the vulnerability of the product portfolio to transition risk and thus earning capacity of real estate portfolios.	All

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Assets	Location	Area of buildings, plants or properties located in designed flood hazard areas	Percentage probability, costs to insure in local currency	GRESB: Q15.1, 15.2 SASB: IF0401- 13, 02-13	Flooding risks can result in physical damage to properties, affecting their serviceability. Understanding the potential impacts of flooding risks and the related financial implications informs investors about potential changes to in the earning capacity of real estate portfolios.	All
			Square meters or acres	SASB: IF0402- 13		
Assets	GHG emissions	A breakdown of reserves and an indication of associated emissions factors to provide insight into potential future emissions	Metric ton (MT) of carbon dioxide emissions (CO ₂ e)	SASB: NR0101-23	A transition to a low-carbon economy may affect the value of reserves. Providing insight into potential future emissions can help to inform investors about the potential impacts of regulatory measures and demand changes on earning capacity.	Real estate

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Assets	Risk Adaptation & Mitigation	For each property type, the percentage certified as sustainable	Percentage	GRESB: NC5.2/ CA2/Q30.1/ Q30.2/Q31	Regulatory measures such as carbon pricing as well as transition to low-carbon properties may affect the financial viability of existing properties. Understanding the percentage certified as sustainable (against relevant indices) provides investors with an indication about the potential impact of regulatory measures and demand changes on earning capacity of real estate portfolios.	Real estate
Assets	Risk Adaptation & Mitigation	Investment (CapEx) in low-carbon alternatives (e.g., capital equipment or assets)	Local currency	GRI 302-5	Investments in new technologies are needed to manage transition risk. The level of investment provides an indication of the level to which the future earning capacity of the core business might be affected.	All

Metrics for the Agriculture, Food and Forest Products Group – Illustrative examples

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Revenues	Risk Adaptation & Mitigation	Revenues/ savings from investments in low-carbon alternatives (e.g., R&D, equipment, products or services)	Local currency	CDP: CC3.2, 3.3, 6.1	New products and revenue streams from climate-related products and services and the return on investments of CapEx projects that create operational efficiencies.	All
Expenditures	Risk Adaptation & Mitigation	Expenditures (OpEx) for low-carbon/water alternatives (e.g., R&D, equipment, products or services)	Local currency	GRI: G4-OG2 CDP: EU4.3	Expenditures for new technologies are needed to manage transition risk. The level of expenditures provides an indication of the level to which future earning capacity of core business might be affected.	All
Expenditures	Water	Total water withdrawn and total water consumed	Cubic meters	SASB: CN0101-06	Water stress can result in an increased cost of supply, factual inability to produce and/or legislation to regulate water withdrawn for production. The quantity of water consumed and percent withdrawn in high water-stress areas inform the risk of significant costs or limitations to production capacity.	All
Expenditures	Water	Percent of water withdrawn and consumed in regions with high or extremely high baseline water stress	Percentage	SASB: CN0101-06		Beverage, Agriculture, Packed foods and meats
Assets	Water	Amount of assets committed in regions with high or extremely high baseline water stress	Number of assets, value, percentage of total assets	SASB: IF0101-06	Water stress can result in limitations to production capacity or enforced demolition of assets. The level of assets in high water-stress areas informs the potential implications on asset valuation.	All

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Assets	GHG emissions	Non-mechanical (Scope 1): Emissions of biological processes	MTCO ₂ e	CDP: FBT 1.3c	For agriculture, non-mechanical emission sources are greater than mechanical sources. Reliance on biological systems means emissions or removals of GHGs generally occurs through much more complex mechanisms than emissions from mechanical equipment used in farmland. It is important to understand the scope of an organization's land-related biological emissions, as well as recent or potential changes due to continuous processes and/or discrete events, to assess the financial and regulatory impact on an organization's production and land use.	All
Assets	GHG emissions/ Land use	Land use change (Scope 1): changes of carbon stock as a result of land use and land use change (e.g., from the conversion of native habitats into farmlands)	MT of CO ₂ e	CDP: FBT 1.3c	For agriculture, non-mechanical emission sources are greater than mechanical sources. Reliance on biological systems means emissions or removals of GHGs generally occurs through much more complex mechanisms than emissions from mechanical equipment used in farmland. It is important to understand the scope of an organization's land-related biological emissions, as well as recent or potential changes due to continuous processes and/or discrete events, to assess the financial and regulatory impact on an organization's production and land use.	Agriculture, Packed foods and meats, Paper and forest products

Financial category	Climate-related category	Example Metric	Unit of measure	Alignment	Rationale for inclusion	Applicable Sub-sectors
Expenditures	GHG emissions	Mechanical (Scope 1): Emissions from equipment or machinery operated on farms/plants	MT of CO ₂ e	SASB: CN0101-01, CDP FBT 1.3b	Relatively high carbon emissions in the value chain are expected to result in regulations (including carbon prices) to drive lower emissions from products. This can result in a significant decrease in future earning capacity.	Agriculture, Paper and forest products
Expenditures	GHG emissions	Purchased energy (Scope 2): Emissions from purchased heat, steam, and electricity consumed on the farm/plant	MT of CO ₂ e	CDP: FBT 1.3b		Agriculture, Packed foods and meats, Paper and forest products
Assets	Risk Adaptation & Mitigation	Investment (CapEx) in low-carbon/water alternatives (e.g., capital equipment or assets)	Local currency	GRI: G4-OG2 CDP: EU4.3	Investments in new technologies are needed to manage transition risk. The level of investment provides an indication of the level to which future earning capacity of core business might be affected.	All

Annex 9. Sector-related questions of the CDP Climate Change Program

Energy

- ✓ In certain countries, e.g. Italy, the UK, the USA, electricity suppliers are required by regulation to incorporate a certain amount of renewable electricity in their energy mix. Is your organization subject to such regulatory requirements?
- ✓ Give the contribution of renewable electricity to your organization's EBITDA in the current reporting year in either monetary terms or as a percentage.
- ✓ Give the projected contribution of renewable electricity to your organization's EBITDA at a given point in the future in either monetary terms or as a percentage.
- ✓ Give the capital expenses (Capex) planned for the development of renewable electricity capacity in monetary terms and as a percentage of total capex planned for power generation in the current capex plan.
- ✓ Select the energy sources/fuels that you use to generate electricity in the country(ies)
 - where you operate:
 - Hydro
 - Other renewable energies
 - Solid biomass
 - Thermal, including solid biomass

Agriculture

1. Agriculture

- ✓ Are agricultural activities, whether in your direct operations or elsewhere in your value chain, relevant for your climate change disclosure?
- ✓ Are the agricultural activities identified as relevant undertaken on your own farm(s), elsewhere in your value chain, or both?
- ✓ Do you account for greenhouse gas emissions from agricultural activities undertaken in your own farm(s) as part of the global gross Scope 1 emissions figure reported in CC8.2 and/or the Scope 2 reported in CC8.3a of the core climate change questionnaire?
- ✓ Select the form(s) in which you wish to report the greenhouse gas emissions produced by agricultural activities (agricultural emissions) undertaken on your own farm(s).
- ✓ Report your agricultural emissions produced on your own farm(s), disaggregated by category, and identify any exclusions.
- ✓ Do you implement agricultural management practices on your own farm(s) with a climate change mitigation and/or adaptation benefit?
- ✓ Identify agricultural management practices undertaken on your own farm(s) with a climate change mitigation and/or adaptation benefit.
- ✓ Does your implementation of these agricultural management practices have other impacts?
 - Impact on yield
 - Impact on cost
 - Impact on soil quality
 - Impact on biodiversity
 - Impact on water
 - Other impact

- ✓ Do you have any plans to implement agricultural management practices in the future? Please, detail your plans.
- ✓ Is biogenic carbon pertaining to your own farm(s) relevant to your climate change disclosure?
- ✓ Report biogenic carbon data pertaining to your own farm(s).
- ✓ Do you account for greenhouse gas emissions from agricultural activities in your value chain as part of the Scope 3 category “Purchased goods and services” reported in CC14.1 of the core climate change questionnaire?
- ✓ Report these agricultural emissions from your value chain and identify any exclusions.
- ✓ Do you encourage your agricultural suppliers to undertake any agricultural management practices with a climate change mitigation and/or adaptation benefit?
- ✓ Identify the agricultural management practices with a climate change mitigation and/or adaptation benefit that you encourage your suppliers to implement.
- ✓ Does the implementation of these agricultural management practices in your value chain have other impacts?
- ✓ Do you have any plans to engage with your suppliers on their implementation of agricultural management practices? Please, detail such plans.

2. Processing

- ✓ Are the processing activities, whether in your direct operations or elsewhere in your value chain, relevant to your climate change disclosure?
- ✓ Are the processing activities that you have identified as relevant undertaken in your direct operations, elsewhere in your value chain, or both?

- ✓ Do you account for emissions from processing activities in your direct operations as part of the global gross Scope 1 emissions figure reported in CC8.2a and/or the Scope 2 figure reported in CC8.3a of the core climate change questionnaire?
- ✓ Report these emissions from processing activities in your direct operations and identify any exclusions.

3. Distribution

- ✓ Are distribution activities, whether in your direct operations or elsewhere in your value chain, relevant to your climate change disclosure?
- ✓ Are the distribution activities that you have identified as relevant undertaken in your direct operations, elsewhere in your value chain, or both?
- ✓ Do you account for emissions from distribution activities in your direct operations as part of the global gross Scope 1 emissions figure reported in CC8.2 and/or the Scope 2 figure reported in CC8.3a of the core climate change questionnaire?
- ✓ Report these emissions from distribution activities in your direct operations and identify any exclusions.

4. Consumption

- ✓ Are emissions from the consumption of your products relevant to your climate change disclosure?
- ✓ Do you account for emissions from the consumption of your products as part of the Scope 3 category “Use of sold products” and/or “End of life treatment of sold products” in CC14.1 of the core climate change questionnaire?

Transportation

1. Sales Volumes

- ✓ Sales of gas/petrol vehicles - Total of countries and per country
- ✓ Sales of gas/petrol vehicles - Passenger vehicles
- ✓ Sales of gas/petrol vehicles - Light Trucks and SUVs
- ✓ Sales of gas/petrol vehicles - Imports
- ✓ Sales of gas/petrol vehicles - Domestic production
- ✓ Companies should provide an explanation if different segmentation of vehicle is used or if data is unavailable commercially sensitive.
- ✓ Sales of diesel vehicles - Total of countries and per country
- ✓ Companies should provide an explanation if different segmentation of vehicle is used or if data is unavailable commercially sensitive.
- ✓ Sales of battery electric vehicles (BEV) per region.
- ✓ Sales of plug-in hybrid electric vehicles (PHEV) per region.
- ✓ Sales of other alternatively-powered vehicles - Total of countries
- ✓ Companies should provide an explanation if different segmentation of vehicle is used or if data is unavailable commercially sensitive.

2. Regulatory Compliance

- ✓ Explain any historic and anticipated changes in the CO₂ emissions profile of vehicles sold (e.g. introduction of clean technologies, changes to sales mix) for the time period 2009–2020.
- ✓ Explain the methodology used to calculate CO₂ emissions from sold vehicles and any differences with data published by industry associations or governmental agencies or the methodologies they have used.
- ✓ Sales-weighted fleet average CO₂ emissions for all vehicles sold, before the received credits.
- ✓ Sales-weighted fleet average CO₂ emissions for all vehicles sold, after credits received.
- ✓ Sales-weighted regulatory parameters.
- ✓ Companies should provide an explanation if different segmentation of vehicle is used or if data is unavailable commercially sensitive.

3. Clean Technologies

- ✓ Auto-manufacturers only – give the percentage of your range of vehicles for which the following technologies are available:
 - Technology category – ICE
 - Technology category – Hybrids
 - Technology category – Zero emissions
 - Technology category – Transmission
 - Technology category – Body
 - Technology category – Others

- ✓ Auto-equipment manufacturers only – select the technology categories that are relevant to your business.

- ✓ Auto-equipment manufacturers only – Provide details for existing and new BEV and FCV models available during the current reporting period:
 - Model name
 - Technology
 - Market
 - Retail price currency
 - Market retail price
 - Range units
 - Urban electric range
 - Extra-urban electric range
 - Combined electric range
 - Minimum electric charge time (hours)
 - Maximum electric charge time (hours)

- ✓ Auto-manufacturers only – Provide details for existing and new PHEV models available during the current reporting period:
 - Model name
 - Technology
 - Market
 - Retail price currency
 - Market retail price
 - Range units
 - Urban electric range
 - Extra-urban electric range
 - Combined electric range
 - Minimum electric charge time (hours)
 - Maximum electric charge time (hours)

- ✓ Auto manufacturers only– Indicate your spend in the following research and development (R&D) categories for the reporting year:
 - Optimizing combustion engine vehicles
 - Traditional hybrids
 - Advanced vehicles (BEV, PHEV, FCV)
 - Autonomous vehicles
 - Other

- ✓ Both auto manufacturers and auto-equipment manufacturers: provide an explanation if data cannot be provided according to the proposed nomenclature or if it is unavailable or commercially sensitive.

Source: (CDP, 2016)



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