HONG KONG MONETARY AUTHORITY
香港金融管理局

Guidelines for Banking Sector Climate Risk Stress Test

April 2023

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1. Overview

In 2021, the Hong Kong Monetary Authority (HKMA) undertook a pilot exercise on climate risk stress test (CRST) to assess the climate resilience of the Hong Kong banking sector and facilitate the capability building of participating authorized institutions (AIs) in measuring climate risks. Drawing on the experience gained from the pilot exercise and the participating AIs' feedback, the HKMA has enhanced the CRST framework with a view to obtaining a more comprehensive assessment of AIs' exposures to climate risks and further strengthening AIs' capability in managing climate risks. AIs participating in the CRST exercise under the enhanced framework are expected to gain a deep understanding of their potential vulnerabilities to climate risks and be able to formulate suitable strategic responses to managing these risks.

As laid down in the HKMA's Supervisory Policy Manual module GS-1, AIs are expected to use climate-focused scenario analysis in managing their climate risk. In addition, considering that climate change is a continual source of risks to AIs, the HKMA intends to integrate the CRST into its supervisor-driven stress testing (SDST) framework. To harmonise with the SDST cycle and reduce the reporting burden on the participating AIs, this round of the CRST will be undertaken over an extended period spanning from June 2023 to June 2024.

It is important to note that the scenarios referenced in the CRST exercise are not the HKMA's forecast of climate change, economic developments or their consequential effects in the future. They are hypothetical and developed solely to assess the banking sector's resilience under extreme emission pathways, which are unlikely to occur and are commonly referred to as "tail events" in the financial sector. The underlying assumptions for the key drivers under the scenarios are made sufficiently severe for AIs to quantify the "tail" risk of these low-probability events, rather than the risk of the most plausible outcomes.

1.1 Key features of 2023-2024 CRST exercise

As compared to the pilot exercise, the HKMA has made several major enhancements to the CRST framework in respect of climate scenarios, assumptions, assessment approaches and reporting requirements. Participating AIs, especially those which took part in the pilot exercise, are expected to make further advancement in their assessment having regard to the lessons learnt from the previous exercise, such as using more granular data and sophisticated approaches in projecting the impacts of climate risks.

1.1.1 Climate scenarios

The 2023-2024 CRST exercise continues to focus on two major types of climate risks, namely physical risk and transition risk. Besides, as the adverse financial impacts brought about by climate risks may materialise simultaneously with those stemming from general macroeconomic shocks, a new scenario is introduced to capture the non-climate risk factors that may present additional stresses on top of those from climate

risks. This scenario will become an important component of the SDST for assessing AIs' downside risks more comprehensively from both the traditional macroeconomic and climate perspectives. In essence, the 2023-2024 CRST exercise comprises the following two sets of complementary scenarios:

(i) A short-term scenario with an assessment horizon from 2023 to 2027, featuring both climate-related shocks and a macroeconomic downturn; and

(ii) Three long-term scenarios with an assessment horizon from 2023 to 2050, adopted from the third vintage of the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) scenarios and covering the following paths of transition respectively:
- Below 2 °C (i.e. orderly transition);
- Delayed Transition (i.e. disorderly transition); and
- Current Policies (i.e. transition limited to that brought about by implemented policies).

As compared to the pilot exercise, a broader set of scenario variables and assumptions, including sectoral impacts and macroeconomic indicators, will be provided to AIs participating in the 2023-2024 CRST exercise. This will support more granular, consistent and comparable assessments under the scenarios. Details of the scenario specifications will be discussed in Chapter 2.

1.1.2 Balance sheet assumption

Participating AIs are required to adopt a static balance sheet assumption under both the short-term and long-term scenarios as the exercise aims to identify participating AIs' vulnerabilities in respect of their latest actual financial positions under the current business strategies. Specifically, participating AIs need to estimate the impacts of the shocks set out in the scenarios on their balance sheet positions as at the end of December 2022, and should not assume to take on any new positions or to reduce any existing positions over the assessment horizons. They should assume to roll over their maturing positions, but not to replenish the defaulted exposures.

Nevertheless, participating AIs may consider adjusting their portfolio mix in their assessments under two of the long-term scenarios (i.e. the Below 2 °C and Delayed Transition scenarios) if they have already established clear climate strategies with measurable commitments or goals on transition. These commitments or goals could be, for instance, achieving net zero financed emissions or gradually exiting certain business sectors after a specific period of time. In these cases, participating AIs are expected to have proper governance to ensure honouring their commitments or achieving the goals. Participating AIs should not assume any growth or reduction in the size of their balance sheets, regardless of any projected changes in their portfolio mix. Further details of this aspect and other assessment requirements will be discussed in Chapter 3.

1.1.3 Sectoral impact analysis

AIs participating in the 2023-2024 CRST exercise are required to analyse the impacts on their exposures to different business sectors under the scenarios, especially those sectors that are vulnerable to climate-related shocks. To enhance participating AIs' consistency in performing the analyses and facilitate comparison and aggregation of their results by the HKMA, assumptions on the key financial performance indicators of these vulnerable sectors will be provided. In this connection, participating AIs should follow the definitions of the Global Industry Classification Standard[1] (GICS) in segmenting their exposures for the sectoral impact analysis. As the China Industry Classification for National Economic Activities (CIC) is also adopted by some AIs in segmenting their exposures to Mainland corporates, a table mapping the GICS to the CIC will be provided to participating AIs to facilitate their analyses.

1.1.4 Reporting standards

Reporting standards which are more detailed than those adopted in the pilot exercise have been developed for each of the scenarios in the second round of the CRST. These standards include an expanded set of metrics with sufficient granularity in terms of risk factors, business sectors and geographical locations to support supervisory analysis and comparison of results across AIs. Details of the reporting requirements will be further discussed in Chapter 4.

[1] Definitions of business sectors under the GICS can be found at https://www.spglobal.com/spdji/en/landing/topic/gics/.

2. Scenario narratives and specifications

The 2023-2024 CRST exercise comprises two sets of scenarios with different assessment horizons. The short-term scenario is a new one combining climate-related and macroeconomic shocks, while the three long-term scenarios are developed based on a subset of the latest NGFS scenarios[2]. Key risk drivers of these scenarios are summarised in Table 1 below. As noted above, these scenarios are not the HKMA's forecast of climate change, economic developments or their consequential effects in the future. They are hypothetical and developed solely to assess the banking sector's resilience under extreme emission pathways, which are unlikely to occur and are commonly referred to as "tail events" in the financial sector. The underlying assumptions for the key drivers under the scenarios are made sufficiently severe for AIs to quantify the "tail" risk of these low-probability events, rather than the risk of the most plausible outcomes.

Table 1: Key risk drivers of the 2023-2024 CRST scenarios

<table>
<tr><th colspan="2">Scenario and assessment horizon</th><th>Climate risk drivers</th><th>Macroeconomic risk drivers</th></tr>
<tr><td colspan="2">Short-term
2023-2027</td><td>▪ More frequent occurrences of extreme climate events
▪ Accelerated transition to a low-emission economy</td><td>▪ Global economic downturn
▪ Hong Kong in recession
▪ Slowdown in Mainland China</td></tr>
<tr><td rowspan="3">Long-term
2023-2050</td><td>Below 2 °C</td><td>▪ Progressive transition in an orderly manner</td><td rowspan="3">▪ No additional macroeconomic risk drivers</td></tr>
<tr><td>Delayed Transition</td><td>▪ Slow transition in initial years, with accelerated transition after 2030 (i.e. disorderly transition)</td></tr>
<tr><td>Current Policies</td><td>▪ Transition limited to that brought about by policies implemented before end-2022
▪ Significant changes in climate patterns with more extreme climate events</td></tr>
</table>

[2] Specifically, scenario variables for the 2023-2024 CRST are developed based on variables adopted from the NiGEM NGFS v1.22 model (configuration: REMIND-MAgPIE 3.0-4.4), with adjustments made for reflecting the latest macroeconomic developments in 2022 and 2023.

Changes in climate patterns and transition indicators including carbon price, energy mix and emissions are provided for each of these scenarios. Details and the paths of these scenario variables, as well as macroeconomic and sector-level performance indicators, will be shared with participating AIs separately.

2.1 Short-term scenario

The short-term scenario features both a downturn in global economy and policy actions for an accelerated transition amid more occurrences of extreme climate events. Under the scenario, Hong Kong slips into a recession while the economic growth of Mainland China slows down significantly. The economic doldrums and high interest rates lead to a substantial correction in the residential property prices of Hong Kong over the 5-year assessment horizon. Unemployment rate in Hong Kong continues to climb as the economy deteriorates. Elaboration of the short-term scenario in the form of a scenario narrative is given in Box 1.

Box 1: Narrative of the short-term scenario

The global economic growth is adversely affected by the synchronised monetary tightening in major developed economies to combat high inflation. Meanwhile, more frequent occurrences of extreme climate events have prompted policy makers in major jurisdictions to make decisive moves to reduce carbon emissions with a view to alleviating the long-term environmental consequences. Stringent measures, such as implementation of carbon pricing systems, are rolled out to accelerate the phasing out of fossil fuels and transition to a low-emission economy. However, these measures have pushed up energy prices as there remain significant gaps between green energies and power demand in the short term, fuelling inflation and dragging down the already sluggish global economy further.

Ongoing headwinds, such as the negative impact of a broad-based slowdown in global economic activities on external demand and a lacklustre domestic property market, significantly weaken the economic growth of Mainland China. The growth is subject to further downward revision as the Mainland government continues to push forward the agenda for achieving its carbon neutral goal by promoting investments that facilitate the transition and imposing stringent control over greenhouse gas emissions. The top high-emitting industries, namely oil and gas, coal, chemicals, cement, steel, non-ferrous metals, paper, construction, airlines and freight logistics, marine and electric utilities, have to bear significant increases in expenditures and their profitability is substantially reduced. More frequent prolonged heatwaves and heavy precipitation also weigh on the economy as activities related to many industries, such as manufacturing, construction and mining, have to be slowed down or even suspended intermittently. Overall, the GDP growth of Mainland China continues to decelerate over the 5-year period during the persistent weakness of the global economy and the transition to a more sustainable economy.

The Hong Kong economy slips into a recession with worsening household income and unemployment rate owing to the economic slowdown in Mainland China and interest rate hike in the US. Credit quality of borrowers deteriorates, leading to widened credit spreads and increases in default rates. Asset prices fall amid the downturn. The valuation of properties in low-lying areas is subject to a larger shock than that of other properties as the market starts to price in the potential damages to these properties by the more intense tropical cyclones in Hong Kong. While the recession bottoms out after 3 years of consecutive contraction, the economy still struggles to achieve a full-scale recovery.

Physical risk

During the 5-year assessment horizon, precipitation and tropical cyclones in Hong Kong with severity sufficient to cause damages to properties occur more often than those observed historically. A number of extreme climate events are assumed for each year between 2023 and 2027. Details of the parameters of the assumed climate events will be provided to participating AIs separately.

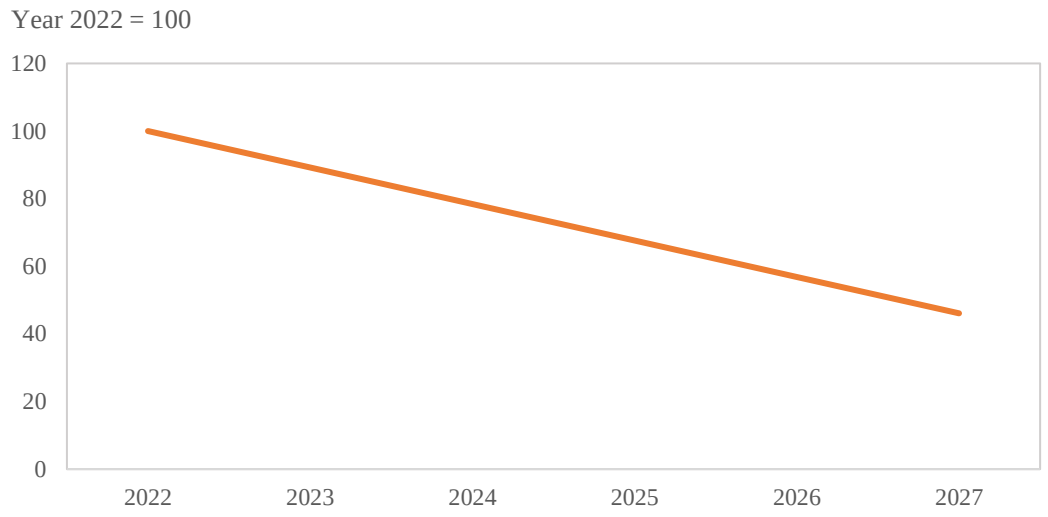
It is assumed in the short-term scenario that climate hazards in Mainland China in each year of the assessment horizon are comparable to the extreme precipitation and heatwave experienced in 2021 and 2022 respectively. The impacts of these climate hazards mainly manifest through damages to physical assets, and disruptions to business activities and industrial production. Participating AIs can refer to the website of the National Climate Centre[3] for details of historical climate hazards occurred in Mainland China.

Transition risk

The transition policies in major jurisdictions including Mainland China lead to a spike in carbon price and provide incentives to corporates to transit to low-emitting business models. Corporates involved in high-emitting activities are adversely affected by both increasing operational costs and shrinking demands amid a sluggish economic environment. There are significant investments in renewable energies and emission reduction technologies, such as carbon capture and storage, but there are limited breakthroughs in new technologies within the 5-year assessment horizon. The phase-out of coal is more pressing than that of oil and gas given its heavier carbon emissions. This, together with the gap between supply of green energies and power demand, pushes up the prices of oil and gas throughout the assessment horizon. Notwithstanding this, carbon emissions in Mainland China are reduced by 54% during the period. Charts 1-3 depict the pathways of carbon emissions, carbon price and commodity price under the short-term scenario.

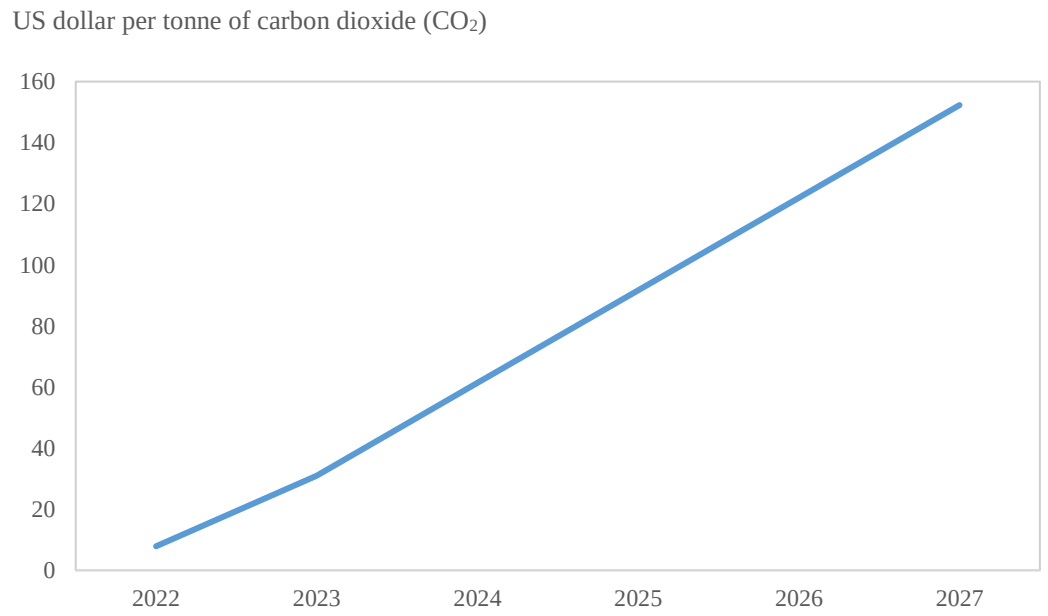
[3] Website of the National Climate Centre: http://cmdp.ncc-cma.net/cn/monitoring.htm#.

Chart 1: Carbon emissions index in Mainland China under the short-term scenario



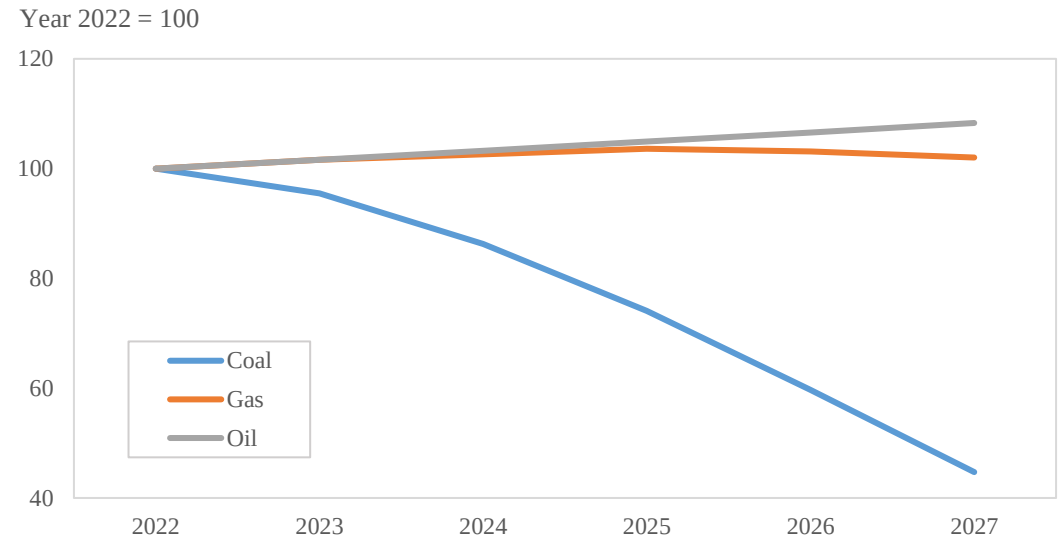
Source: HKMA

Chart 2: Carbon price in Mainland China under the short-term scenario



Source: HKMA

Chart 3: World commodity price index under the short-term scenario



Source: HKMA

2.2 Long-term scenarios

The three long-term scenarios are based on a subset of the third vintage of the NGFS scenarios, i.e., Below 2 ºC, Delayed Transition and Current Policies. Consistent with the setting of the NGFS, all jurisdictions are assumed to undertake policy actions in line with the narratives under each of the below climate scenarios.

(i) **Below 2 ºC:** Climate policies are introduced immediately and become more stringent gradually to achieve an orderly transition;

(ii) **Delayed Transition:** New climate policies are not introduced until 2030, resulting in a disorderly transition; and

(iii) **Current Policies:** No new climate policy is introduced, while policies implemented before the end of 2022 are preserved.

Brief narratives of the long-term scenarios are provided in Box 2 and more detailed descriptions of the scenarios can be found in the website of the NGFS[4].

Box 2: Narratives of the long-term scenarios

Below 2 ºC

Collective global actions are taken immediately to reduce emissions towards a target of limiting global warming to below 2 ºC as compared to the pre-industrial level by the end of the century. Carbon price increases gradually from 2023 to 2050. As a result of the early and progressive policy measures, both physical and transition risks are relatively modest. The global economy experiences a short-term adjustment at

[4] NGFS website: https://www.ngfs.net/ngfs-scenarios-portal/explore/

the beginning of the transition but benefits from the transition in the long run with sustainable productivity.

Delayed Transition
New climate policies are not introduced until 2030. Due to the delayed actions, strong and aggressive policies are required to limit global warming to below 2 ºC by the end of the century. The policy measures lead to a jump in carbon price and a slowdown in economic growth. Inflation pressure is also seen throughout the 2030s after the introduction of the policies due to the shortage of substitutes for traditional energies.

Current Policies
Transition policies implemented before the end of 2022 are preserved and no new measure is introduced since then. Emissions continue to grow until 2080, leading to global warming exceeding 3 °C by the end of the century and a significant increase in physical risk. Productivity and economic activities are adversely affected gradually by the increasingly serious and frequent climate hazards, and irreversible changes in climate patterns.

Physical risk

Under the Current Policies scenario, carbon emissions continue to increase and global warming reaches 2 °C by the middle of the 21st century as compared to the pre-industrial level, leading to non-linear and irreversible adverse changes in climate patterns. To capture the potential catastrophic impacts of global warming, it is assumed that global warming is having a major impact on ice sheet processes and sea level keeps on rising as a result. Hong Kong is severely affected by the elevating global warming with the mean air temperature and sea level rising significantly. The rise in temperature and sea level, together with noticeable increases in precipitation and the number of violent tropical cyclones, poses larger threats to Hong Kong than climate events observed in the past.

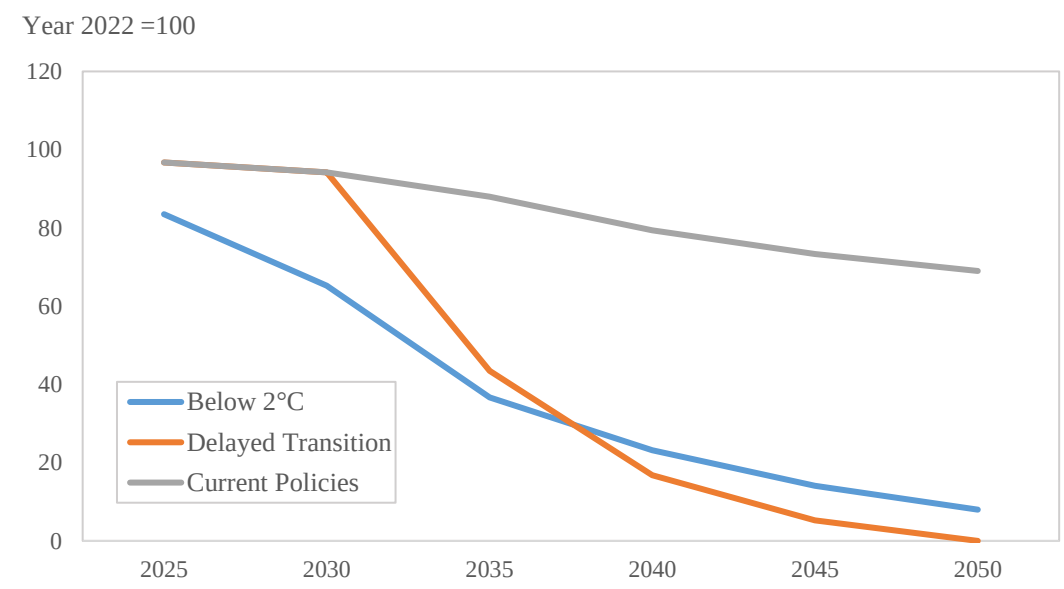
The impacts of physical risk under both the Below 2 ºC and Delayed Transition scenarios are relatively contained compared to the Current Policies scenario throughout the assessment horizon, partly attributable to the reduction in carbon emissions driven by the transition policies.

Transition risk

The Below 2 ºC and Delayed Transition scenarios share the same target of limiting global warming to below 2 ºC within this century as compared to the pre-industrial level. However, the Delayed Transition scenario assumes that new policies are not introduced until 2030. From then on, a sharp increase in emission costs is required to expedite the reduction in carbon emissions to achieve the target. Under the Current Policies scenario, movements in carbon price are limited throughout the assessment

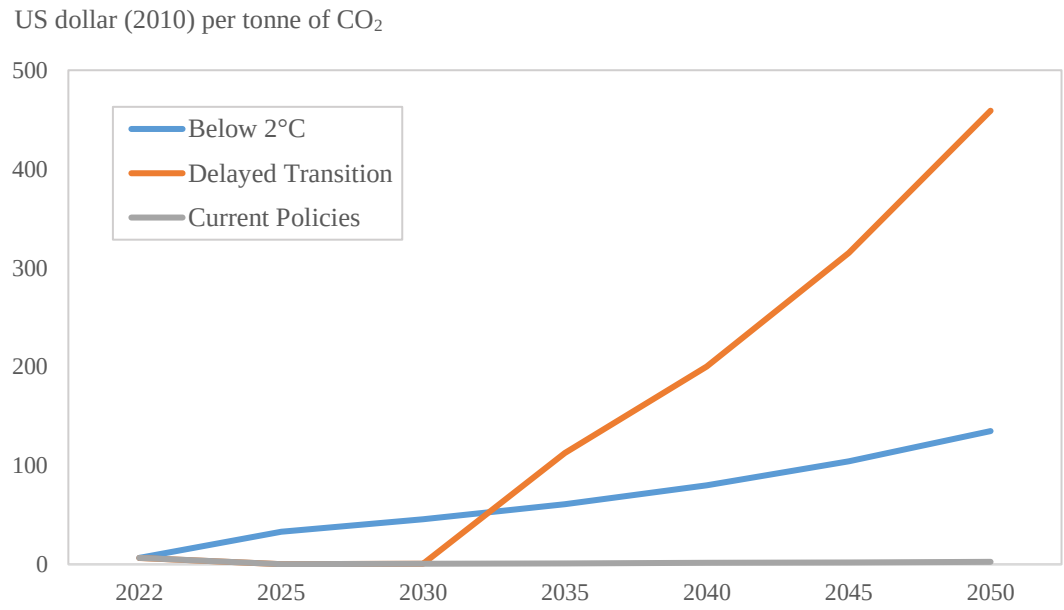
horizon, and changes in carbon emissions and energy mix are much more gradual than those under the other two long-term scenarios. Charts 4-6 display the carbon emissions index, carbon price and energy mix in Mainland China under the long-term scenarios respectively.

Chart 4: Carbon emissions index in Mainland China under the long-term scenarios



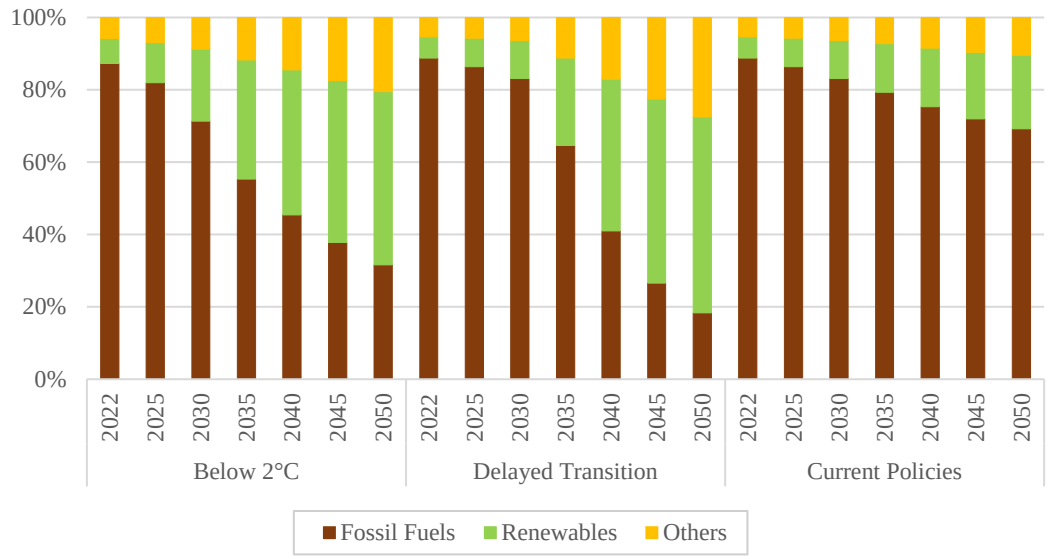
Source: NGFS

Chart 5: Carbon price in Mainland China under the long-term scenarios



Source: NGFS

Chart 6: Primary energy mix[5] in Mainland China under the long-term scenarios



Source: NGFS

2.3 Sectoral impacts under transition

Individual sectors' decarbonisation pathways to achieve the emissions target depend on various factors such as market demand for the sectors' output, and availability of low-carbon substitutes and technologies to reduce emissions. Generally speaking, industries involving high-emitting business activities are exposed to higher risks along the transition. The following paragraphs describe the decarbonisation pathways of selected industries which tend to be affected the most by transition policies.

Traditional energies

Traditional energy industries involving fossil fuels such as coal, oil and gas are significantly affected along the transition especially in the long run. The overall demand for fossil fuel products does not drop abruptly at the initial stage of the transition due to a lack of alternative energy sources at reasonable costs. However, such demand weakens gradually as fossil fuel products are replaced by cleaner energies over time.

- Coal: The demand for coal shrinks continuously as downstream industries phase out the use of coal and switch to other energy sources.

- Oil and gas: The demand for oil and gas picks up initially during the transition as they are preferable to coal and the supply of cleaner energies are not yet sufficient to replace the traditional energies. However, corporates in the sector need to put in

[5] "Fossil fuels" includes coal, oil and gas; "Renewables" includes non-biomass renewable fuels; and "Others" includes nuclear and biomass fuels.

significant efforts to bring down their production costs to offset the costs associated with carbon emissions and transit themselves to a low-emitting business model.

Materials

While switching away from using coal-fired electricity can help lower part of the emission costs, corporates in the material industries are in general facing both financial and technological challenges as significant investments are needed to enhance their production processes and adopt technologies for effective carbon capture.

- Cement: This is one of the most adversely affected industries by transition policies. The production of cement is energy-intensive with significant amounts of emissions. The decarbonisation of the production process relies heavily on the carbon capture technologies which are immature and expensive at the initial stage of the transition.

- Steel and chemicals: The key challenge facing these industries is also the unavailability of commercially viable solutions to lower emissions especially during early years of the transition. Significant investments are required to push forward the technological transformation.

- Non-ferrous metals: The industry is less affected than cement, steel and chemicals. Emissions can be lowered by upgrading the production processes and reducing the reliance on electricity generated by traditional energies. The costs for lowering the emissions remain high at the initial stage. However, the demand for non-ferrous metals is strong due to their extensive use in electrification supporting the transition, and this helps transfer some of the costs to downstream industries.

Utilities

The share of electricity in the overall energy consumption continues to rise with the advancement in the decarbonisation of power generation process. However, traditional coal-fired plants need to be equipped with carbon capture facilities and may have to operate at low capacity due to the enormous costs associated with the emissions.

Transportation

The emissions from land transport gradually reduce as electric vehicles become increasingly prevalent, and more efficient low-carbon fuels are available and put to use. However, the transition of shipping and aviation is much more difficult due to a lack of alternative clean-energy solutions to long distance transport which requires the use of heavy energies. Some of the costs associated with the emissions are externalised given the services are still in demand as the transition progresses.

Other industries

Industries other than those mentioned above generally account for a relatively small portion of total carbon emissions. These industries are nevertheless dependent on or interconnected with the high-emitting industries and therefore are also affected by the transition. While the transition risk facing these industries in general is lower than that facing the high-emitting industries, the impact would hinge on other factors such as collective bargaining power versus the upstream and downstream industries, and availability of substitutes for the products or services provided by these industries.

The performance of individual industries basically follows the course of developments described above for a generic transition pathway. Table 2 summarises the variations in such developments having regard to the transition pathways characterising the CRST scenarios.

Table 2: Differences in transition developments under the CRST scenarios

Scenario		Transition developments
Short-term		▪ Significant increases in costs due to accelerated transition policies and limited technology breakthroughs within the assessment horizon ▪ Demand dragged down by economic downturn
Long-term	Below 2 ^{o}C	▪ Significant investments required at initial stage ▪ Decarbonisation costs reduced gradually with the advancement in technologies ▪ Production demand changes along the transition
	Delayed Transition	▪ Slow technology advancement in decarbonisation at initial stage ▪ Sharp increase in decarbonisation costs after 2030 ▪ Production demand changes along the transition at an accelerated pace after 2030
	Current Policies	▪ Limited transition risk

2.4 Scenario expansion

Participating AIs can use additional climate change factors, as well as financial and economic parameters for performing the CRST (i.e. scenario expansion). These additional parameters should be broadly consistent with the stress scenarios set out in sections 2.1 and 2.2 in terms of both direction and severity, and supported by empirical study or internal analysis as appropriate. If expert judgement is involved, participating AIs should provide the rationale behind and evaluate the implications of the judgement made on the stress test results. All the additional parameters, and the relevant analyses

and processes should be documented and submitted to the HKMA together with the stress test results.

If the additional parameters for scenario expansion exhibit significant inconsistencies with the parameters specified in the scenarios set out in sections 2.1 and 2.2, participating AIs should approach the HKMA in advance to demonstrate the reasonableness of such an expansion.

3. Assessment requirements

Participating AIs should use suitable approaches and methodologies to capture climate risks (and macroeconomic risks under the short-term scenario) and assess the financial impacts on them having regard to the transmission mechanisms of these risks. This chapter sets out the HKMA's requirements for AIs participating in the exercise in respect of the scope and approaches of assessment.

3.1 Scope of assessment

Participating AIs are required to assess the impact of climate risks (and macroeconomic risks under the short-term scenario) on their entire balance sheets as well as off-balance sheet exposures under the CRST scenarios. They are expected to conduct in-depth analyses of their exposures directly affected by climate-related shocks. Certain directly-affected exposures are listed in Table 3 below for participating AIs' reference. Participating AIs should also identify other material exposures which are significantly, but may not be directly, affected by climate-related shocks under the scenarios, and conduct analyses in a similar fashion as appropriate.

Table 3: Exposures directly affected by climate risks

Climate risks	Directly-affected exposures
Physical risk	▪ Lending with properties as collateral (e.g. mortgages) and property investment of which the underlying properties are prone to damages under extreme climate events ▪ Exposures to clients whose credit quality will be affected by extreme climate events ▪ Participating AIs' operational losses associated with extreme climate events
Transition risk	▪ Credit and market risk exposures (including loans and advances, debt securities and equity investments) to corporates whose financial performance is directly affected by carbon price and transition policies (e.g. corporates in high-emitting industries)

3.2 Assessment approaches

Participating AIs should use a combination of quantitative and qualitative analyses to evaluate the stress impacts comprehensively under each scenario. Both the quantitative and qualitative analyses should be well documented covering the whole assessment process, including assumptions, data and methodologies used in the analyses and justifications for their usage. The HKMA may request for such information for review.

3.2.1 Quantitative analyses

For quantitative analyses, participating AIs need to quantify how climate risks are transmitted and manifested in the following major risk categories:

(i) **Credit risk** arising from deterioration in the credit quality of participating AIs' customers due to changes in business environment or devaluation of collateral;

(ii) **Market risk** caused by fair-value movements of market assets, such as debt securities and equities, which could be induced by instantaneous shocks to participating AIs' trading portfolio or fundamental changes affecting the valuation of market assets held by participating AIs; and

(iii) **Operational risk** resulted from damages to premises and disruptions to business activities brought about by extreme climate events.

3.2.2 Qualitative analyses

Participating AIs are required to conduct qualitative analyses in the following areas:

(i) **Risk drivers:** Participating AIs should identify all the risk factors which materially affect their financial positions and operations under the scenarios;

(ii) **Assumptions and parameters:** Participating AIs should list out the key stress test assumptions and parameters which are not prescribed by the HKMA, and document the relevant analyses showing how these assumptions and parameters are derived and demonstrating that they are consistent with the stress scenarios;

(iii) **Major limitations of assessment:** Participating AIs should evaluate the major limitations of their assessment including:

- Data gaps and approximation approaches;
- Assessment assumptions and methodologies; and
- Other relevant challenges.

3.2.3 Balance sheet treatment

Participating AIs should assume a static balance sheet under both the short-term scenario and the long-term scenarios. Static balance sheet means that the size and portfolio mix of an AI's balance sheet stay unchanged throughout the assessment horizon. For the purpose of the 2023-2024 CRST, participating AIs should use their balance sheet position as at 31 December 2022 as the initial position for assessment. There would be no new loans and the maturing positions would be rolled over throughout the assessment horizon. An exception is defaulted exposures, which would not be replenished when they are written off.

If net profit is projected during the assessment horizon, participating AIs may assume distribution of the profit in the form of dividends with pay-out ratios (after excluding any extra-ordinary items contributing to the net profit and special dividends) comparable to the average in 2018 to 2022. Any retained earnings should be placed in non-interest bearing accounts.

Participating AIs may assume changes in their portfolio mix under the Below 2 ^{o}C and Delayed Transition scenarios if the following criteria are met:

(i) The participating AIs have established clear climate strategies with measurable commitments or goals on transition which have been endorsed by the AIs' board of directors by the time when the exercise commences;

(ii) The commitments or goals are reasonable and consistent with the AIs' projections of business developments along the scenario pathways;

(iii) The commitments or goals are measurable with quantitative targets, especially those related to the AIs' plans for reducing their climate risk exposures or making investments in new opportunities to support transition; and

(iv) The change in portfolio mix will not give rise to any change in the size of the AIs' balance sheets over the assessment horizon.

Participating AIs should provide sufficient evidence to demonstrate to the HKMA that the above criteria are met and explain how the strategies would result in the assumed changes in their portfolio mix under each scenario. Any assumed changes should only take place after 2025 under the Below 2 ^{o}C scenario or after 2035 under the Delayed Transition scenario. Participating AIs should adopt conservative assumptions on the benefits brought about by the assumed changes and refrain from being too optimistic with respect to, for instance, the reduction in credit cost by exiting certain risky exposures and the upside of any new green investments made.

3.2.4 Physical risk assessment

Participating AIs should evaluate the financial impacts of climate hazards on their exposures under both the short-term scenario and the Current Policies scenario.

3.2.4.1 Exposures in Hong Kong

Participating AIs' physical risk assessment should cover the impacts of tropical cyclones and flooding in Hong Kong on the following exposures:

(i) Mortgages and other types of property-related lending[6];

[6] It refers to lending for property development and investment, and any other lending (including refinancing loans) that is secured by a property.

(ii) AIs' own property investment;

(iii) Exposures to other obligors whose credit quality are significantly affected by extreme climate events in Hong Kong; and

(iv) Operational losses associated with extreme climate events in Hong Kong.

Generally speaking, participating AIs should take into account both changes in climate patterns and macroeconomic developments prescribed in the scenarios in assessing the stress impact on (i), (ii) and (iii). The analyses should cover the impact on clients' financial situations and repayment abilities for exposures in (i) and (iii). For exposures in (i) and (ii), participating AIs should evaluate the potential damages to the underlying assets in geographical locations exposed to extreme climate events. Such assessments should be sufficiently granular to cover at least the 26 coastal low-lying and windy residential areas in Hong Kong identified in the "Study of Coastal Hazards under Climate Change and Extreme Weather and Formulation of Improvement Measures - Feasibility Study" published by the Civil Engineering and Development Department in 2022 (the CEDD Study). Market perceptions of the valuation of properties located in the vulnerable areas should also be considered in estimating the potential impact on these exposures. For the sake of conservativeness, participating AIs should not take account of any climate adaptation and mitigation measures (e.g. insurance coverage) in quantifying the impact under the Current Policies scenario. However, insurance coverage that existed as of the end of 2022 might be taken into account in the assessment up to its expiry under the short-term scenario. Renewal of such insurance coverage after expiry should not be assumed.

Regarding the impact of extreme climate events on participating AIs' operations, participating AIs should estimate the repair costs of the damaged premises and equipment, and the loss of revenue due to disruptions to business activities.

Participating AIs may make additional assumptions for the above analyses. If they do so, they should ensure these assumptions are relevant, conservative and consistent with the scenarios.

3.2.4.2 Exposures outside of Hong Kong

Participating AIs should endeavour to assess the physical risk of their exposures outside of Hong Kong based on their own risk identification results and make best efforts to fulfil the requirements set out in section 3.2.4.1 in the assessment, with the exception of using the CEDD Study in identifying the vulnerable locations.

As discussed in section 2.1, heavy precipitation and prolonged heatwaves in Mainland China are assumed in the short-term scenario. The economic impact of these climate hazards have been reflected in the stress assumptions prescribed in the scenario such as GDP growth and financial performance of certain industries. To facilitate the

understanding of the standalone impact of extreme climate events, participating AIs are required to identify their key exposures that would be severely affected by these two types of hazards and perform separate analyses of the associated impact on these key exposures by referencing to two historical events, i.e. (1) the extreme precipitation in Mainland China in 2021 and (2) the prolonged heatwave in Mainland China in 2022.

3.2.5 Transition risk assessment

Participating AIs should assess the impact of transition on their financial positions under both the short-term scenario and the long-term scenarios. Sector-level assessment is required for all corporate exposures, supplemented by granular analyses of material exposures to high-emitting corporates identified by participating AIs.

3.2.5.1 Sectoral impact analysis

For the purpose of the 2023-2024 CRST exercise, participating AIs should follow the definitions of the GICS to classify their corporate exposures based on corporates' major business activities. Participating AIs using the CIC in their internal risk management can make use of the mapping table to be provided by the HKMA to classify their exposures. Exposures to Mainland corporates which have been categorised by the Mainland authorities using the CIC should also be classified accordingly for the CRST. Should a participating AI use a different mapping or approach to classify its exposures to corporates, it should inform the HKMA in advance and provide details of its classification approach. The HKMA will assess the appropriateness of the AI's mapping or approach and provide feedback where necessary.

Eleven business sectors are identified as either high-emitting ones or those which tend to be severely affected by transition policies, including oil and gas, coal, chemicals, cement, steel, non-ferrous metals, paper, construction, airlines and freight logistics, marine and electric utilities. Participating AIs are required to conduct a more granular assessment of the transition risk of their exposures to these sectors. To facilitate participating AIs' analyses, a set of variable pathways indicating the general business performance of each of these sectors will be provided. As these variable pathways do not reflect individual corporates' business strategies and competitiveness in the respective sectors, participating AIs should take account of this counterparty-level information in their sectoral impact analysis. In particular, corporates in these sectors may eventually default on their financial obligations if they do not adopt a sustainable business strategy under the transition. In this regard, the HKMA considers it important for participating AIs to conduct detailed studies on their counterparties to which they have material exposures, and document their counterparty-level assessment to ascertain and demonstrate the reasonableness of their sectoral impact analysis.

While participating AIs may make additional assumptions about the performance of business sectors and individual corporates, they should provide sufficient evidence or justifications to substantiate those assumptions that deviate significantly from the prescribed variable pathways. In the event that a participating AI does not have

sufficient data for a detailed and accurate assessment of certain exposures, it should make reasonable and conservative assumptions for performing the analysis.

3.2.5.2 Short-term scenario

Participating AIs should prudently assess their corporate obligors' vulnerabilities to both the transition policies and unfavourable economic environment assumed under the scenario. They can take into account factors that may help offset some of the emission costs borne by certain high-emitting corporates, such as relative competitiveness of a corporate within a particular sector and the ability of a corporate to transfer its emission costs to downstream customers. Notwithstanding this, participating AIs should fully reflect in their analyses that corporates have to make substantial investments for transition and thus their short-term profitability is significantly affected.

Exposures to non-corporates, such as retail exposures, also need to be assessed. Participating AIs may perform the assessment of these exposures based on the macroeconomic variables provided by the HKMA.

3.2.5.3 Long-term scenarios

Participating AIs may use approaches similar to those adopted in the assessment under the short-term scenario for evaluating the transition risk under the long-term scenarios. One difference from the short-term scenario assessment is that participating AIs may factor in their corporate obligors' transition plans in the assessment under the long-term scenarios if the participating AIs have scrutinised such plans and consider them feasible. Additional assumptions for making the long-term projections can be adopted, provided that there is clear elaboration of the basis of these assumptions and that these assumptions are consistent with the scenarios.

3.2.6 Key assessment metrics and projection interval

Participating AIs are required to make projections of key metrics of their financial performance under each of the scenarios, such as capital adequacy ratios, expected credit losses, risk weighted assets, probability of default of their corporate obligors, fair value of assets and operational losses. The projections should be made and reported to the HKMA according to the intervals prescribed in Table 4.

Table 4: Projection interval

Scenario	Projection horizon	Projection interval
Short-term	2023-2027	Every year
Long-term	2023-2050	Every 5 years (2025, 2030, 2035 and so on)

3.2.7 Model risk assessment

Participating AIs may adopt new modelling methodologies and assumptions for performing analyses and making long-term projections. Since the use of these methodologies and assumptions may entail significant model risk in the stress test results, participating AIs are required to assess the model risk by estimating the potential variations in the stress test results under different modelling methodologies or assumptions. For instance, a participating AI may use sensitivity analysis in assessing the model risk. Participating AIs should document the assessment and include it in their submission to the HKMA.

4. Submission of results

4.1 Results reporting

The HKMA has developed two sets of reporting templates for the short-term scenario and long-term scenarios respectively. Participating AIs should submit their CRST results using these templates. In addition to the key assessment metrics discussed in section 3.2.6, participating AIs are required to provide the following information in their submission to the HKMA:

(i) Breakdown of property-related lending by region (i.e. Hong Kong and non-Hong Kong);

(ii) Breakdown of Hong Kong property-related lending of which the underlying properties are located in vulnerable areas[7];

(iii) Interest income generated from loan exposures to corporate sectors; and

(iv) Projected financial summaries under each scenario.

Apart from the reporting templates, participating AIs are required to submit an overview of their assessment highlighting the key financial impacts and risk drivers, description of methodologies used in the analyses and major findings from the stress testing results. Participating AIs should also submit the relevant analysis and methodology documents for the HKMA's review. The submission should be endorsed by participating AIs' senior management. Where necessary, the HKMA may request for additional information or documents to facilitate its review.

4.2 Submission timeline

Participating AIs should submit the CRST results for the short-term scenario and long-term scenarios separately in accordance with the timeline set out below. If a participating AI encounters difficulties in meeting the submission deadline, it should approach the HKMA in advance.

(i) **Results for short-term scenario:** Participating AIs that are required to conduct the regular SDST in 2023 should submit the results for the short-term scenario by 31 December 2023. Other participating AIs should submit the results for the short-term scenario no later than 30 June 2024.

[7] The breakdown should cover at least the 26 vulnerable areas identified in the CEDD Study. The locations should be reported by using Tertiary Planning Unit (TPU) adopted in the 2021 Population Census in Hong Kong, which is available at https://data.gov.hk/en-data/dataset/hk-pland-pland1-boundaries-of-tpu-sb-vc/resource/e9a15b3b-6f5e-4502-99c4-8f6954aef002.

(ii) **Results for long-term scenarios:** All participating AIs should submit the results for the three long-term scenarios by 30 June 2024.

Annex Useful resources

Some useful resources related to climate risk analyses are available via the web links below. Participating AIs may make reference to these materials in conducting the CRST.

Description	Link
HKMA's Green and Sustainable Finance (GSF) Data Source Repository	https://www.hkma.gov.hk/eng/key-functions/international-financial-centre/green-and-sustainable-finance/gsf-data-source-repository/
NGFS Phase 3 Scenario Explorer	https://data.ene.iiasa.ac.at/ngfs/#/workspaces
NGFS Scenario Narratives	https://www.ngfs.net/ngfs-scenarios-portal/explore/
Climate Impacts Explorer by Climate Analytics	https://climate-impact-explorer.climateanalytics.org/
National Climate Centre	http://cmdp.ncc-cma.net/cn/monitoring.htm#
Climate change information by Hong Kong Observatory	https://www.hko.gov.hk/en/climate_change/climate_change.htm