Investor Group on Climate Change

ASIA INVESTOR GROUP ON CLIMATE CHANGE

POLICY UPDATE

Central bank climate scenarios: Unpacking the NGFS

July 2020

Overview

The Central Banks and Supervisors Network for Greening the Financial System (NGFS) is a group of central banks and supervisors established in 2017 to enhance the role of the financial system to manage the systemic risks posed by climate change and to mobilize capital for green and low-carbon investments.

To identify, quantify and mitigate climate risks to the economy, the financial system and the safety and soundness of financial firms, the NGFS published its first set of climate scenarios in June 2020 (NGFS scenarios). The NGFS scenarios and guide to scenario analysis provide a common starting point for analysing climate risks to the economy and financial system.

The NGFS scenarios are categorised into groups – Orderly, Disorderly and Hot house world.

1. **Orderly:** Early, ambitious action to a net zero emissions economy. In these Orderly scenarios the economic impact of the transition is "relatively small" (4% GDP loss by the end of the century).
2. **Disorderly:** Action that is late, disruptive, sudden and/or unanticipated. Emissions reductions need to be sharper than in the Orderly scenario to limit warming to the same target. The result is higher transition risk and significantly large economic impacts than an orderly transition (8-10% GDP loss by the end of the century).
3. **Hot house world:** Assumes currently implemented policies and as a result emissions grow until 2080 leading to 3°C+ of warming and severe physical risks. In the Hot house world scenario physical damages result in up to an annual 25% GDP loss by 2100.

The development of these scenarios will have significant implications for investors, companies, national financial regulators and for governments and policymakers.

To demonstrate how the NGFS scenarios can be used, AIGCC and IGCC have developed an assessment of transition risks in the energy sector in Asia drawing upon the NGFS work. The energy sector in Asia will need to decarbonise rapidly to meet the objectives of the Paris Agreement, and this has significant implications for Australia as a major exporter of coal and gas to the region.

The NGFS scenarios indicate that both current and future coal and gas capacity faces significant transition risks if policies are aligned with the objectives of the Paris Agreement. This is the case under both the early (Orderly) and delayed (Disorderly) action scenarios. Renewable energy investment is robust under all scenarios.

Achieving the objectives of the Paris Agreement will require around US$1 trillion investment a year in the Asian energy sector between now and 2050. This is around US$330 billion more than is required under business as usual scenarios.

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About the NGFS

The NGFS is a collaboration of central banks and supervisors established in 2017 to enhance the role of the financial system to manage the systemic risks posed by climate change and to mobilise capital for green and low-carbon investments. Today, the NGFS has 66 central banks as members with 13 observers and defines and promotes best practices to be implemented by supervisory authorities. It is a highly influential network which is driving the development of regulatory practice across a broad range of markets and jurisdictions - including in Australia, New Zealand and Asia.

The NGFS is structured into three workstreams: (1) to encourage central banks and supervisors to integrate climate-related risks into micro-supervision (chaired by the People's Bank of China), (2) macroprudential and sizing climate-related risks to the economy and the financial system (chaired by the Bank of England), and (3) scaling-up green finance (chaired by Deutsche Bundesbank).

Current members from the Asia Pacific region include Bank of Indonesia, Bank of Japan, Bank of Korea, Bank of Thailand, Hong Kong Monetary Authority, Japan FSA, Monetary Authority of Singapore, People's Bank of China, Reserve Bank of Australia, and Reserve Bank of New Zealand.

To identify, quantify and mitigate climate risks to the economy, the financial system, and the safety and soundness of financial firms, the NGFS published its first set of climate scenarios[1] (NGFS scenarios) alongside a user guide to climate scenario analysis[2] for forward looking climate risk assessment on 24 June 2020. This builds on earlier work conducted by the Bank of England to test the resilience of the UK's largest banks and insurers, and the finance system more broadly, to the physical and transition risks associated with different possible climate scenarios[3].

The NGFS scearios provide a common starting point for analysing climate risks, while the guide provides practical advice on using scenario analysis to assess these risks to the economy and financial system. This is in line with NGFS previous recommendations[4] which identified the need for a consistent set of climate change scenarios to enhance the comparability of different analyses.

Besides central banks and supervisors, these scenarios will provide a benchmark for a wide range of players including financial firms, companies and policy makers to better understand how climate factors will drive changes in the economy and lead to financial impacts at national, sectoral and company levels and balance sheets. Such scenario analysis can inform climate risk management strategies in line with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations. Publicly available databases[5] provide a starting point for in-house analysis.

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Overview of the NGFS Scenarios

The NGFS scenarios are aligned with categories set out in the NGFS Scenarios Matrix (Figure 1) as published in 2019 – Orderly, Disorderly and Hot house world[6].

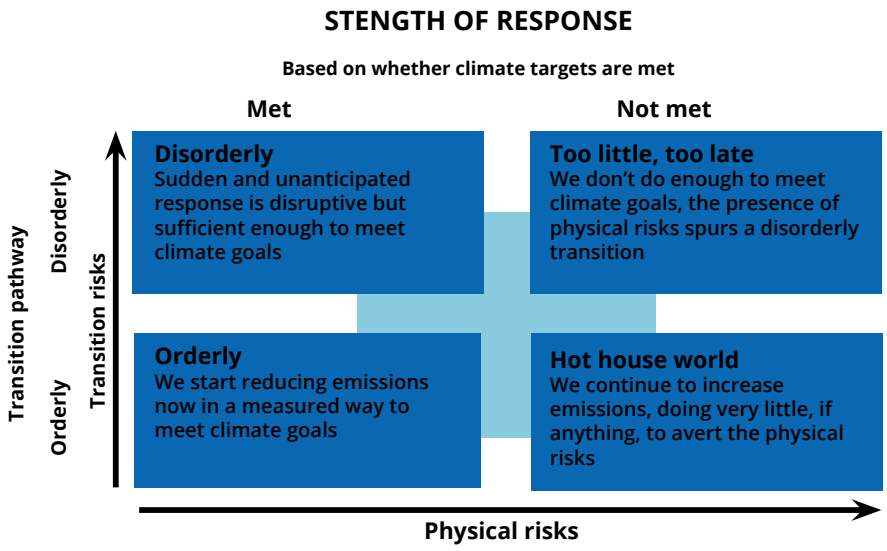
1. **Orderly:** Early, ambitious action to a net zero emissions economy. Orderly assumes climate policies are introduced early and become gradually more stringent with the objectives of limiting global warming to 1.5°C to well below 2°C. Physical and transition risks are both relatively low. In these Orderly scenarios the economic impact of the transition is "relatively small" (4% GDP loss by the end of the century).

2. **Disorderly:** Action that is late, disruptive, sudden and/or unanticipated. Disorderly assumes additional climate policies are not introduced until 2030. Emissions reductions need to be sharper than in the Orderly scenario to limit warming to the same target. The result is higher transition risk and significantly large economic impacts than an orderly transition (8-10% GDP loss by the end of the century).

3. **Hot house world:** Assume currently implemented policies or planned policies as stated in the Nationally Determined Contributions (NDC) under the Paris Agreement are implemented. Emissions grow until 2080 leading to 3°C+ of warming and severe physical risks. In the Hot house world scenario physical damages result in up to an annual 25% GDP loss by 2100. To put this in context, the International Monetary Fund estimates the impact of COVID-19 on global GDP loss will be around 3%. Note that these physical impacts estimates are also subject to a number of limitations. They typically do not adequately account for all sources of risk, including low probability high impact events, sea level rise, extreme events and societal changes like migration and conflict. As the NGFS conclude, "As a result, damages in this scenario will be larger than models suggest, particularly in regions with lower resilience and capacity for adaptation."

Updated scenarios will be published in 2021.

Figure 1: NGFS Climate Scenarios Framework



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Points of Note and Limitations

National and company level analysis: The current model results from the NGFS provide only global and some regional results. To investigate impacts on national economies, portfolios and asset valuation more granular analysis is required[7].

Expectations will fall on central banks and supervisors at the national level to downscale the global or regional model results of both transition and physical risks and conduct market specific stress-test exercises which quantify the potential financial impacts. These include important considerations around the scope of financial risks/products assessed (firm-level, sector level, system-wide), transmission channels (sales/costs/asset values) and firm coverage (banks/insurers/asset managers/asset owners etc.). Assessment methods may be top-down (largely conducted by the central bank/supervisor) or bottom up with voluntary or mandatory participation and firm-level analysis conducted by regulated market actors depending on the jurisdiction.

Like the Bank of England, Japan's Financial Services Agency and the Australian Prudential Regulatory Authority[8] are currently conducting national-level exercises, drawing on the NGFS scenarios. Transparency regarding the choice of scenarios and models for both transition and physical risks will determine the usability of results for more granular analysis.

Transition risk assumptions: Transition risk scenarios are based on assumptions about policy change (emission reduction targets and implied carbon prices), technology (for example availability of carbon dioxide removal (CDR)) and market price projections.

1. **Policy:** Scenario choices about the magnitude and speed of assumed emissions reduction measures will influence economic impact projections for Orderly and Disorderly scenarios respectively. Alignment with the 1.5°C temperature goal will require more rapid carbon reductions versus 2°C.

2. **Technology:** Technology options in the NGFS scenarios are strongly influenced by assumptions of their relative cost. Models notoriously underestimate the penetration of renewable energy into markets and recent substantial cost reductions.

   In addition, assumptions about the relative availability of CDR technologies such as bioenergy and carbon capture and storage as well as afforestation significantly impact the trajectory of required carbon emissions reductions over time (see below). Assuming "limited CDR" as per current utilization rates will mean steeper emissions reduction in a shorter timeframe, while assumed "full availability", as per the representative Orderly scenario, will require less stringent emissions reduction in the short-to medium term as negative abatement is expected to play a significant role in the latter half of the century.

3. **Carbon dioxide removal (CDR):** Action to reduce emissions has been slow over recent decades, and there will be some need for CDR technologies to remain within the 1.5°C limit, or below 2°C. These technologies and practices involve restoring and protecting natural ecosystems to absorb carbon from the atmosphere and technologies to remove carbon dioxide directly from the air (e.g. biomass with carbon capture and storage or direct air capture technologies). The later technologies are in the research, development and early-stage deployment and need greater investment and support. There is considerable uncertainty around the scalability, effectiveness and community acceptance of these emission reduction options[9].

   Differences in CDR technology assumptions are also an important reason why emissions and actions in the International Energy Agency (IEA) scenarios (like IEA's Sustainable Development Scenario) are different from the IPCC and other assessments. The IEA, for example, assumes the availability of large amounts of CDR technologies after 2050 to allow for their scenarios to come close to being consistent with the objectives of the Paris Agreement.

4. **Market:** Assumptions around consumer preferences and economic sentiment that may affect market pricing in the future are not fully captured in the models and thus financial impacts may be underestimated or overestimated.

5. **Physical risk assumptions:** Physical risks are very regionally specific and require downscaled analysis at asset level. Global scenarios may not provide sufficient level of granularity to accurately project physical impacts at the sub-national level, requiring more detailed modelling for each market.

Current global scenarios are assumed to underestimate the magnitude of physical risks associated with low-probability, high impact events and do not include possible impacts from population displacement, migration and conflict that are expected to occur at higher levels of warming.

Improving physical risk estimates will be a strong focus of future NGFS scenario development.

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Implications for Investors of the NGFS Scenarios

The NGFS scenarios clearly demonstrate climate change is a systemic economic threat that will significantly undercut economic activity and long-term investment returns. Financial regulators are now responding to this economic risk, as are institutional investors who are increasingly wary of carbon-intensive assets and looking for opportunities that will accelerate the net-zero emissions transition.

The NGFS have provided a consistent set of global scenarios on physical and transition risks. Through time this will support financial institutions and listed companies to conduct comparable scenario analysis to assess the impact of financial risks from climate change on the value of their assets.

It is, however, important to bear in mind the limitations of chosen scenarios (noted above), the importance of including 1.5°C aligned alternative scenarios in addition to the reference scenarios, and the need to consider tail-end risks that may not be captured in reference scenarios that rely on central assumptions[10].

Besides central banks and supervisors, these scenarios will provide a benchmark for a wide range of players including financial firms, companies and policy makers to better understand how climate factors will drive changes in the economy and lead to financial impacts at national, sectoral, company and asset levels and for balance sheets. Such scenario analysis can inform climate risk management strategies disclosed in line with the TCFD recommendations.

1. **Investor practice:** By undertaking detailed scenario analyses, investors can assess which sectors have high transition or physical risk exposure across different geographies. This analysis can then inform appropriate business strategies and targets and metrics to manage those risks - as recommended by the TCFD.

2. **Engagement with companies:** NGFS scenario analysis for both transition and physical risks can be used as reference points for specific company engagements. For example, to discern whether forward looking business plans are factoring future transition scenarios aligned with achieving the Paris Agreement goals of restricting global temperature rise to 2°C or 1.5°C. Investors can work with companies so that their own scenario analyses are in line with the NGFS scenarios to allow for consistency and comparability of risk assessments between issuers.

3. **Engagement with financial regulators and in-house capacity:** These scenarios will underpin efforts by the financial supervisors to provide a consistent basis for companies and investors to disclose their climate risk exposure. Without waiting for central banks or supervisors, investors should investigate NGFS scenarios and build in-house capacity to undertake such scenario analysis exercises. Raising awareness within firms will be critical for quantified analysis and continual improvement.

4. **Relevance to governments:** To reduce climate-related risks, governments should also apply these climate scenarios to their own policy decisions, including COVID-19 economic recovery efforts.

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Spotlight on Energy in Asia: What is the NGFS Scenarios Project

To demonstrate how the NGFS scenarios can be used, AIGCC and IGCC have developed an assessment of transition risks in the energy sector in Asia drawing upon the NGFS work. Energy trends in Asia are related to one of Australia's key economic exposures to transition risk, namely key export markets shifting away from fossil fuel.

For many countries in Asia, energy related emissions remain the biggest hurdle to aligning emissions pathways with the Paris Agreement and the NGFS scenarios provide a stark reminder of the rapid transition required from fossil fuels towards zero emissions energy sources.

To undertake this analysis, a number of scenarios were chosen from the complete NGFS set as a point of analysis. The scenarios used were:

1. **Hot house world:** To compare different emissions pathways, economic costs of climate change and examine the incremental investment needed to achieve different emissions outcomes.
2. **1.5°C with CDR (Orderly):** 1.5°C scenarios are chosen because the central 2°C scenarios provide low levels of probability that the full range of temperature objectives of the Paris Agreement will be achieved.
3. **1.5°C with limited CDR (Disorderly):** This scenario tests the impact of CDR technologies being limited.
4. **2°C delayed with limited CDR (Disorderly):** In this scenario action is delayed, 1.5°C is not likely to be achieved but action is accelerated after 2030 to limit warming to below 2°C. CDR technologies are limited because early investment and RD&D support does not occur due to delayed policy action.

Global energy sector emissions pathways under these scenarios are shown in Figure 2. In all cases, limiting warming in line with Paris Agreement objectives requires global energy sector emissions to reach zero around 2050. For reference, these are also compared to the emissions projected by the IEA in its Sustainable Development Scenario.

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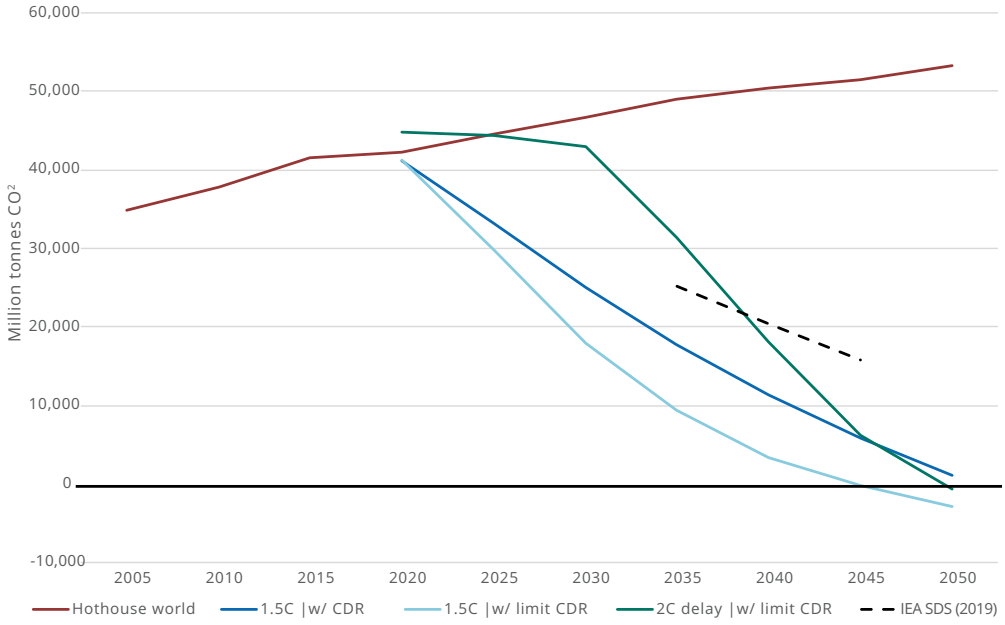
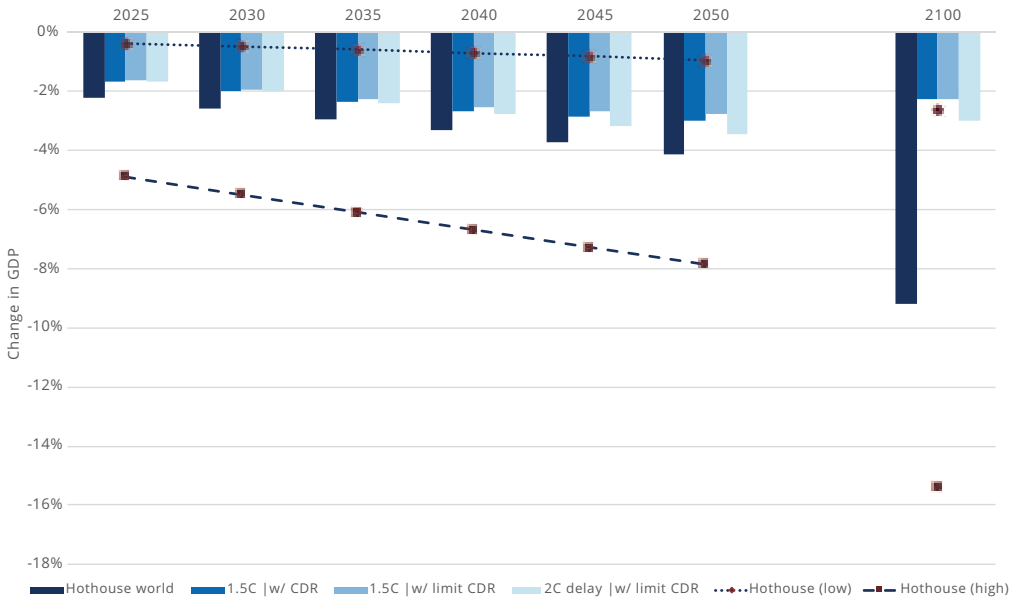
Figure 2: Global carbon dioxide emissions under chosen NGFS scenarios (2005-2050)



The scenarios that limit warming in line with the Paris Agreement objectives produce lower economic damages and costs from climate change itself (Figure 3). Economic damages from climate change in the Hot house world scenario are up to 5-8% of global GDP per year from 2025-50. Note as the NGFS highlight, these are likely to be underestimated. The 2100 figures are included to align with the Bank of England's proposed approach to assessing the physical impacts of climate change which proposes to calibrate their 2020-2050 scenarios by assuming the more material risks anticipated later in the century occur by 2050.

Figure 3: Climate damages under chosen NGFS scenarios (2025-2050 and 2100).



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The Asian Energy System in a Paris-aligned World

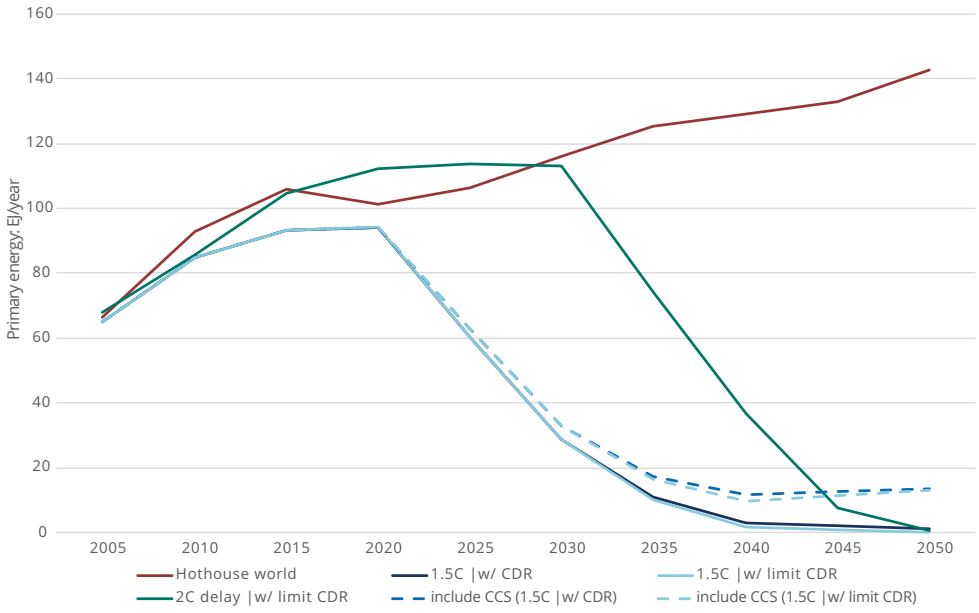
Achieving the objectives of the Paris Agreement requires a major shift in energy supply in Asia[11] (See figure 4)[12].

Figure 4: Change in Asia's energy mix from current policy scenario (ex-Japan) in 2050

Coal

Coal is phased out around 2040-50 (Figure 5). In the absence of carbon, capture and storage (CCS) technologies, the immediate Paris-aligned scenarios require almost the complete phaseout of coal by 2040 whereas the delayed 2°C scenario extends complete phaseout by 5-10 years to 2045-50. Overall, CCS technologies play a limited role in mitigating this outcome due to its cost and emissions intensity.

Figure 5: Asia's coal use under chosen NGFS scenarios (2005-2050)



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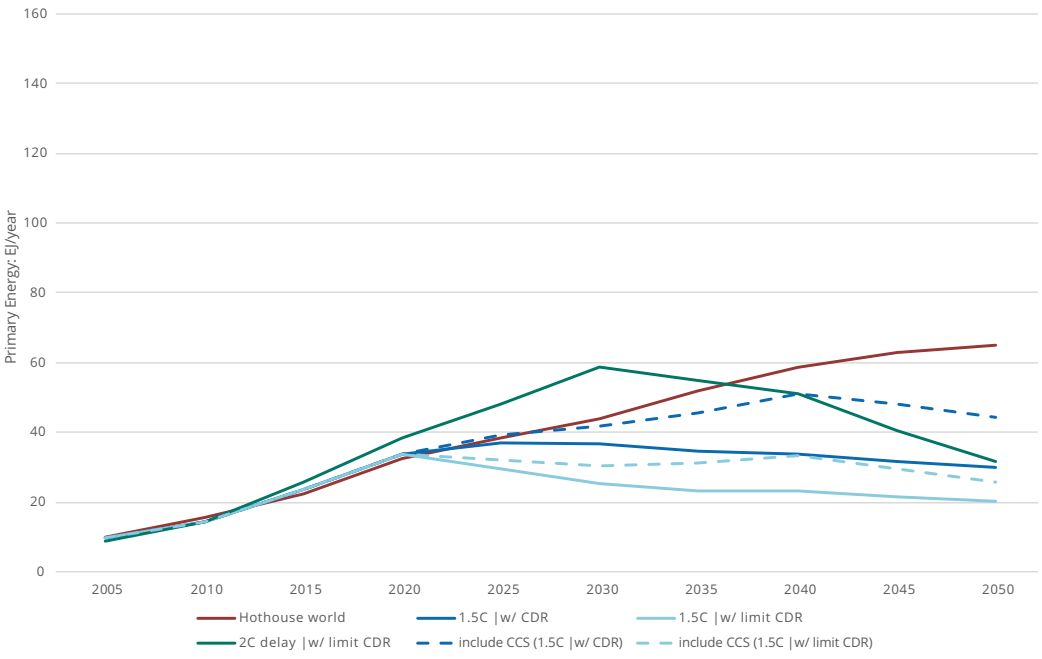
Gas

Gas peaks around 2020-25 and declines towards 2050. Gas use falls by 50-70% below the Hot house world scenario. If gas with CCS is available and competitive with renewable energy and other alternatives it has a much more material impact on scenarios than with coal.

Figure 6: Asia's gas use under chosen NGFS scenarios (2005-2050)



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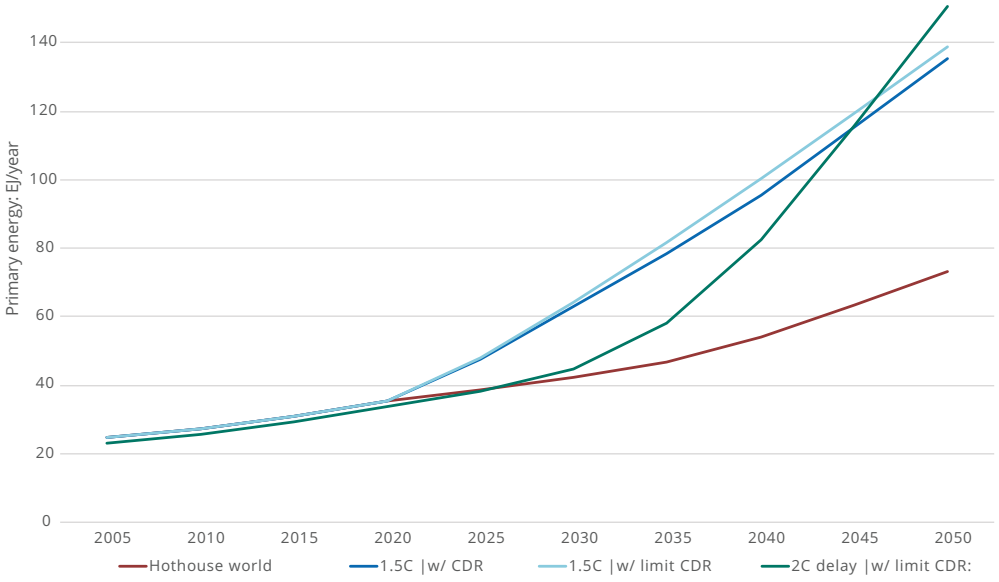
Renewable Energy

Renewable energy production grows under all scenarios. In scenarios which achieve the objectives of the Paris Agreement, by 2050, renewable energy provides the equivalent of 150% current Asian coal use.

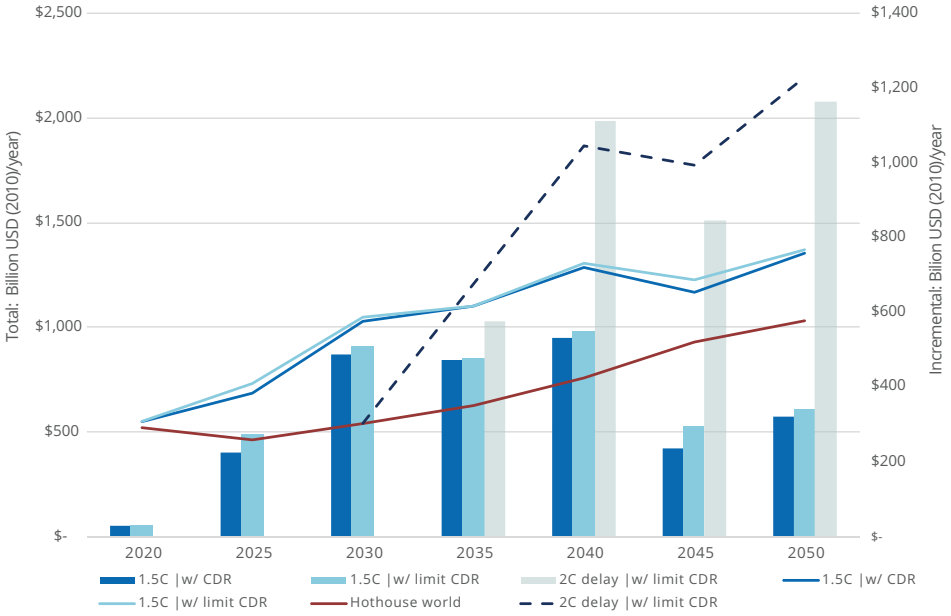
Figure 7: Asia's renewable energy use under chosen NGFS scenarios (2005-2050)



Investment requirements

Achieving the objectives of the Paris Agreement requires around US$1 trillion investment a year in the energy sector between now and 2050. This is around US$330 billion more than is required under business as usual scenarios, or put another way, around US$330 billion dollars a year to avoid catastrophic climate change.

Figure 8: Asia's energy sector investment under chosen NGFS scenarios. Includes total and incremental investment above the Hot house world policy scenario.



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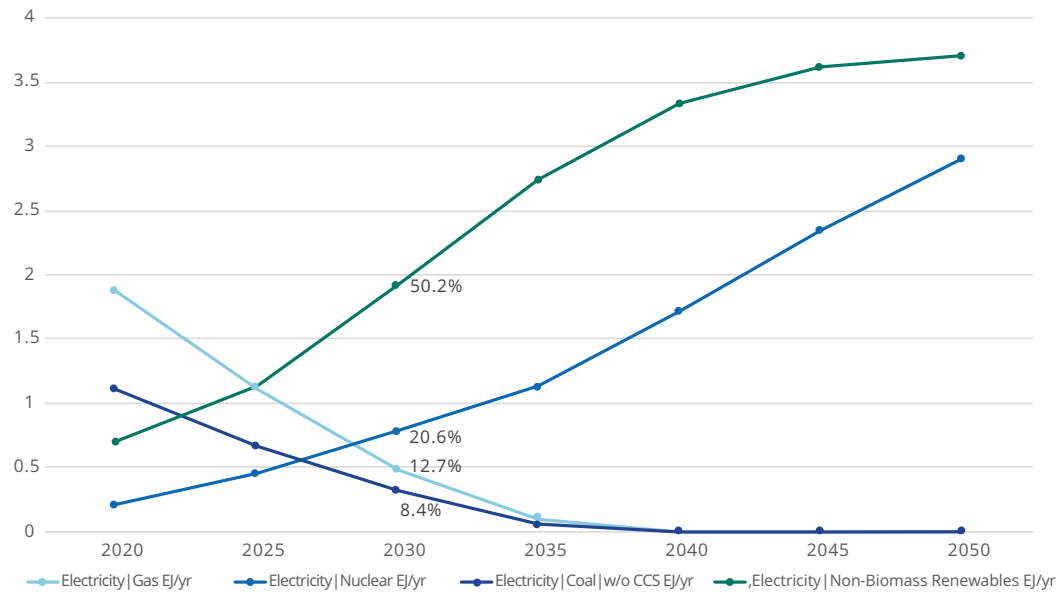
Country example: Japan's electricity mix under a 1.5°C scenario

Relative change from 2020-2050 across coal, gas, nuclear and renewable energy electricity supply in Japan under the 1.5°C with limited CDR scenario can be seen. This demonstrates the rapid changes required in the electricity mix in coming decades.

Figure 9: Japan's energy mix under chosen NGFS scenario, includes total share of electricity by renewable energy, gas, coal, nuclear 2020-2050



According to this alternative scenario, the share of renewables in Japan's electricity mix is required to increase by almost threefold by 2030 (estimated around 50% of total electricity supply), while both coal and gas usage dramatically decrease by almost three quarters (coal reduces to 8% and gas to 13%).

Nuclear is also expected to play a larger role however, and its share of electricity more than doubles by 2030 to 20% of supply. These values can be contrasted to Japan's current 2030 electricity mix set out in its basic energy policy[13], which outlines an "ideal supply" of renewable energy 22 - 24%, nuclear power 22 - 20%, natural gas 27% and coal 26%. This indicates that both current and future coal and gas capacity faces significant transition risks if policies are aligned with restricting global temperature rise to 1.5°C.

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Summary and Conclusion

Financial regulators in many jurisdictions have already signaled that their involvement and participation in the NGFS network is a precursor to undertaking national economic modelling and scenario analysis to better inform both macroeconomic analysis as well as bottom-up financial entity level portfolio or balance sheet assessments.

The NGFS scenarios released in June 2020 form the basis of this work and it represents a critical next step in the evolution of analysis of climate change as an economic and financial risk.

It will also ultimately flow through to a wider range of regulatory requirements and interventions across the financial and the corporate sector in the way in which modern economies understand, manage and price transition and physical risk.

For investors seeking to understand their own portfolio or asset level exposures and mitigate emerging financial risks related to climate change, this work is a vital reference and a useful tool in strengthening investor capacity to assess future scenarios.

Both IGCC and AIGCC will continue to engage with financial regulators, policy-makers and investors across the Asia-Pacific region to understand risks and promote climate solutions which seek to limit global warming to less than 1.5°C and avoid the damages and costs associated with a Hot house world or a Disorderly transition.

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Endnotes

1 https://www.ngfs.net/sites/default/files/medias/documents/ngfs_climate_scenarios_final.pdf

2 https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_scenario_analysis_final.pdf

3 https://www.bankofengland.co.uk/news/2019/december/boe-consults-on-proposals-for-stress-testing-the-financial-stability-implications-of-climate-change

4 These documents follow a technical supplement on climate risk modelling approaches published in July 2019, which identified the need for mapping and rationalizing "high level scenarios to consider how different combinations of physical and transition risk may impact the economy while being flexible enough to account for differences between regions, sectors, industries and firms". https://www.banque-france.fr/sites/default/files/media/2019/08/07/ngfs_report_technical_supplement_final.pdf

5 https://www.ngfs.net/en/publications/ngfs-climate-scenarios

6 https://www.ngfs.net/sites/default/files/medias/documents/ngfs_climate_scenarios_final.pdf. A 'too little, too late' scenario with both high transition and physical risks was not included in the first iteration.

7 For examples see p28 of the NGFS Guide: https://www.ngfs.net/sites/default/files/medias/documents/ngfs_guide_scenario_analysis_final.pdf

8 https://www.apra.gov.au/news-and-publications/apra-outlines-plans-for-climate-risk-prudential-guidance-and-vulnerability

9 https://www.ipcc.ch/sr15/chapter/chapter-2/

10 See the Grantham Research Institute and London School of Economics submission to Bank of England's climate change stress test discussion paper: http://www.lse.ac.uk/granthaminstitute/publication/the-2021-biennial-exploratory-scenario-on-the-financial-risks-from-climate-change-submission-to-the-bank-of-england/

11 Includes Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China (incl. Hong Kong and Macao, excl. Taiwan) Democratic People's Republic of Korea,India, Indonesia, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Singapore, Sri Lanka, Taiwan, Thailand, Timor-Leste,and Vietnam.

12 The use of oil and nuclear were also examined but not included in the rest of the discussion here for reasons of brevity. Overall, nuclear continues to play a relatively small role in all scenarios and oil follows a similar pathway to gas.

13 https://www.enecho.meti.go.jp/en/category/brochures/pdf/japan_energy_2018.pdf