

Sustainable Finance in Asia

Next Steps for Climate Innovation

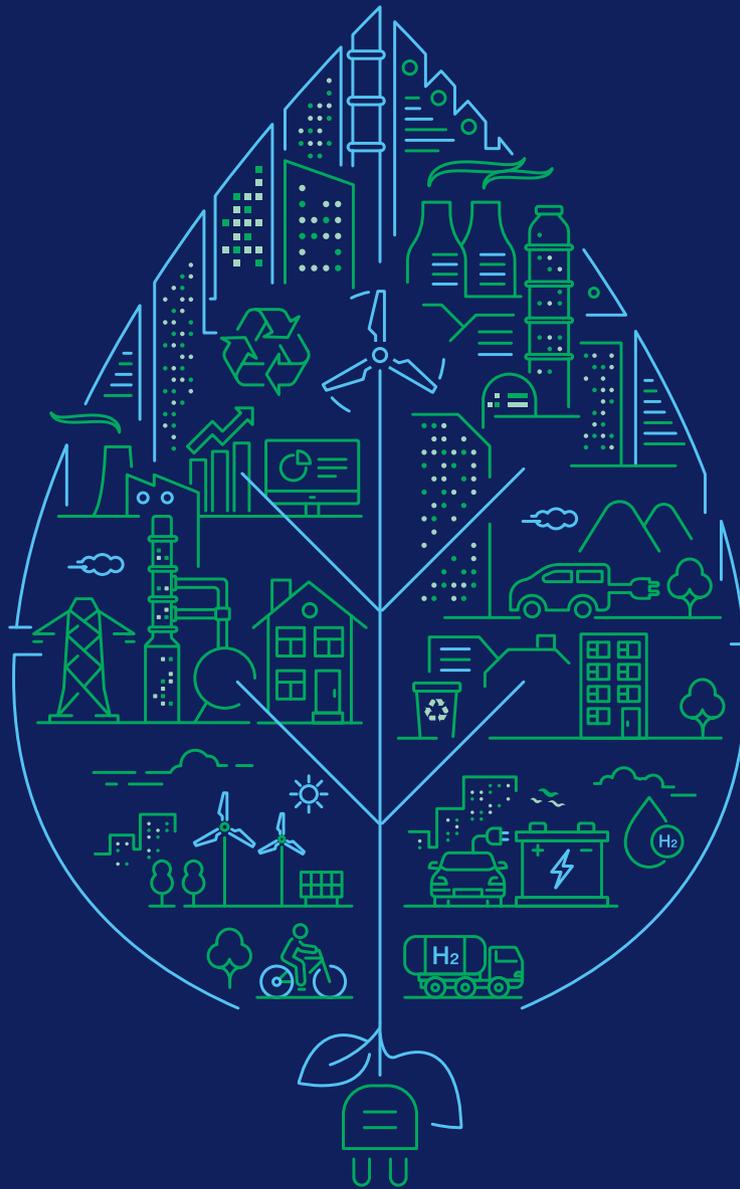


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About This Report

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Stanford Sustainable Finance Initiative (SFI) is an interdisciplinary research initiative at Stanford that works to scale up and accelerate the flow of capital toward the decarbonization of global systems by developing and deploying innovative policies and financial mechanisms, educating leaders, and engaging with the global policy and finance community. SFI engages faculty, fellows, and students in projects within the five focus areas: (1) catalyzing private investment, (2) energy business innovation, (3) risk metrics and management, (4) stranded assets and just transitions, and (5) systems transformation and integration. SFI faculty and fellows work directly with key stakeholders where problems are located, and together we drive toward an implementation pathway so that our work has a measurable impact. Stanford SFI demonstrates its global thought leadership on sustainable finance through its recent publication of the book entitled *Settling Climate Accounts - Navigating the Road to Net zero*.

Stanford Center at the Incheon Global Campus (SCIGC) is a research entity committed to ultimately establishing a “smart city model” by individually or collectively researching and studying the fundamental components that enable a smart and sustainable city. The research focuses not only on the construction of information and communication infrastructure and technology demonstration, but also on finance and economy, related organizations, sustainability, health, social equality and public policy so as to establish an intelligent future city system that can detect in advance and respond to problems that current cities suffer from, such as the gap between the rich and the disadvantaged, along with local, regional, and global environmental challenges.



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Disclaimer

The reports presented in this conference proceeding are published to foster public engagement and discussion with interested stakeholders not only in the Asia-Pacific region but also throughout the world. The views and opinions expressed in the proceeding represent those of the conference speakers and do not necessarily represent those of the host, organizers, sponsors or supporters of the conference.

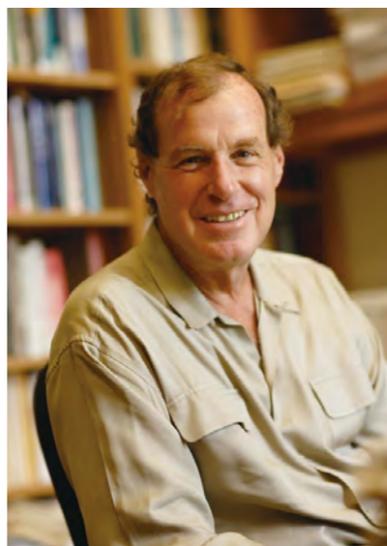
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Message from the Faculty Director



Prof. Thomas Heller

Faculty Director, Stanford Sustainable Finance Initiative
Professor emeritus, Stanford Law School

“Through this Conference, we hoped to develop a better understanding of how different regions with different institutional histories, capacities, and resources will have to consider different time pathways and institutionalized interests to meet the same goals of sustainability and consequential economic growth.”

Looking back to the start of 2022, there were three main driving factors that led the team at Stanford to initiate dialogue on sustainable finance in the Asia Pacific region.

First, I had always hoped that in issues related to sustainability, Stanford would be able to build programs that married the technological expertise that is concentrated in this University with the connected issues of law, policy, and infrastructure finance. Just as in the 20th century when fossil fuels became the core of energy production and reformed the political and regulatory landscape, similarly, as we begin to shift away from fossil fuels, we will need to understand how to redesign policy structures to be able to fully realize the benefits of low carbon development. My fear is that if we build out the technological system without concurrent institutional redesign, we will have a much delayed and more costly power system. I saw the Asia Sustainability Forum as spanning these different dimensions, which included at its core, consultations with leading technological institutions such as the Korea Advanced Institute of Science & Technology (KAIST), funding from the Korea Development Bank (KDB), and having major corporates that were tech leaders as leading parties in the workshop.

Second, Stanford has had a long history of deep engagement with Asia, whether it is through relationships with technology centers such as Tsinghua University in China and the Indian Institute of Technology in India, or the fact that a substantial percentage of Stanford’s demography is students from East, South and Southeast Asia. Most recently, in an initiative chaired by Dr. Arun Majumdar, Stanford has set up the Doerr School of Sustainability, which would be a significant opportunity to not only reform our curriculum but to also build ongoing partnerships between Stanford and other geographies. Stanford also maintains a center for learning and research collaboration in Korea through the Stanford Center at the Incheon Global Campus (SCIGC). Having an established base in Korea presented a natural opportunity for us to make Korea the seat for collaboration. My hope is that this Conference will serve as the foundation stone on how to build co-governance on the western side of the Pacific that would match an evolving set of governance principles on the

home campus on which we could build innovative student and researcher interchange with the Doerr School in the interest of shared learning.

Third, much of the climate policy at the international level had been historically dominated by North America and Europe. Developing countries and Asia, in particular, were largely reactive to what was happening in the West, rather than leading climate plans in ways that were responsive to their own transitions and legacy economic systems. The result of this was that the realities of economic growth and sustainability in Asia were not adequately represented in most of the multinational or regional arrangements that have been shaped over the past thirty years. Strongly privatized climate transition strategies such as ‘Net Zero’ didn’t really describe business models prevalent in China, Korea, Japan, or even India. In Asia, which has just gone through a remarkable economic reformation, the States have retained a significant role as the owner of enterprises and budgeteer of investments, particularly in the pillar sector industries, which include the carbon-intensive energy, transportation, and heavy industries. Korea offers a frontier case study for other Asian countries to understand the different mechanisms and modes of governance because it was active in 2008-10 during the green growth movement, where the state-led efforts to shape a transition policy, and from 2015-17, where we have seen the emergence of the Korean Green & Digital New Deal. Through this Conference, we hoped to develop a better understanding of how different regions with different institutional histories, capacities, and resources will have to consider different time pathways and institutionalized interests to meet the same goals of sustainability and consequential economic growth.

Organizing this conference with stakeholders from various sectors in Korea is not the last, but an important first step in these three overlapping directions. It is my hope that this Conference, the discussions it will create, and this Conference Proceedings Report we have worked on will generate newer ideas and create space and impetus for greater collaboration.

Message from the Research Director



Soh Young In

Financial Innovation Lead, Stanford Sustainable Finance Initiative
 Research Director of Sustainable Finance, Stanford Center
 at the Incheon Global Campus

“A fundamental part of preparing for a sustainable future is truly understanding the risks *and* opportunities of the net zero transition. The discussions in this Report elaborate on the means and impacts of Asia’s transition pathway.”

As the world moves toward the era of net zero carbon, it faces new drivers and pressures to mitigate and adapt to climate change. A growing coalition of countries, cities, companies, and institutions are pledging to decarbonize their entire value chain. A significant portion of carbon-intensive businesses, infrastructures, and assets that have fueled economic development and growth may become stranded as the world weans off fossil fuels. Asia, by far the largest emitter accounting for more than 50% of global emissions, confronts severe issues in regards to transitioning carbon-reliant economies without compromising the trajectory of rapid economic growth.

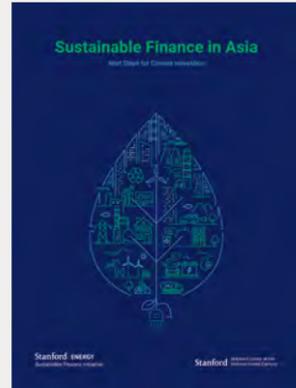
An orderly transition to net zero would require not only the scale of capital allocation but also extensive coordination. This means a need for strong consensus building and correct implementation plans that are tailored to national or regional specificities along with timely reconfiguration through the global value chain. Whilst global narratives set broad milestones and frameworks for the net zero transition, alignment with local needs is important. Asia, in particular, has challenges in addressing misaligned perspectives among global, local, public, and private sectors in terms of who, when, and how they should deploy capital to decarbonize. These debates have led to a significant and growing interest in sustainable finance and investment-related research in Asia.

Responding to such vast interests, the Stanford Sustainable Finance Initiative (SFI) and the Stanford Center at the Incheon Global Campus (SCIGC) hosted two conferences in Seoul, Korea in 2022. The two conferences convened leading scholars, practitioners, and policymakers interested in and working toward Asia’s sustainable transition and posed long-term questions that the global community should respond to. This Report proceeds with the collection of discussions exchanged in this regard.

This Report highlights a suite of innovative solutions that our speakers have shared in developing sustainable investment strategies and responsible policy solutions. A fundamental part of preparing for a sustainable future is truly understanding the risks and opportunities of the net zero transition. The discussions herein elaborate on the means and impacts of the desired transition pathway. The transition requires intelligent market design, sophisticated sustainability assessment tools, and new investment and business models. Systems that successfully navigate these untapped frontiers will generate outsized returns by positioning themselves to be more efficient, flexible, resilient, and environmentally sustainable.

Taking a step forward, Stanford has formed the Asia Sustainability Forum, which aims to facilitate a new paradigm integrating technology, finance, and policy innovation in accelerating the net zero transition in Asia. The Forum highlights what academic research can and should bring to this new paradigm shift, by proposing and implementing forward-looking research ideas. In this regard, we are actively seeking collaborative opportunities with global partners. The solutions, cases, ideas, and proposals that result from the Forum will help the Asian financial system to align with the global sustainability movement, meet the Paris Agreement and the UN’s Sustainable Development Goals, and create net zero pathways appropriate to Asian contexts.

Executive Summary



This Report seeks to set out the key learnings from the Asia Sustainability Forum conferences that took place on March 24th and June 17th 2022 in Seoul, South Korea. The Forum was envisaged to be a collaborative platform where experts from different disciplines in the field of sustainable finance and low-carbon development could convene to discuss how we could align the financial system with the global sustainability goals, how we could fulfill the commitments made in the Paris Agreement and how we could create net zero development pathways, particularly in the context of Asian countries.

The Forum sets five key segments and highlights from conference discussions detailed as follows.

Global Net Zero Landscape



Net zero has emerged as the dominant organizing principle for climate action across the globe. Domestic and international institutions alike, are generating hundreds to thousands of net zero scenarios, but these are all fraught with uncertainties and complexities. The path to net zero poses several challenges along the way whether it is the inadequate technology, the need to secure the interests of the people who will have to bear the burden of the transition or the increasing significance of global solidarity and cooperation that will be required to achieve the goals set out. The common thread to address these challenges will be in the financial systems across the world, particularly in domestic green finance instruments that will be used and funding from developed to developing countries.

Sustainability at the Leading Edge of Technology



Technology is an important component of strategies to reach net zero emissions. The Forum touched upon several critical technological breakthroughs that would be needed to achieve net zero. Some of these are: (1) innovations in the manufacturing industry to reduce reliance on coal, (2) change in the energy source through green hydrogen or nuclear energy, and (3) an increased focus on developing energy storage systems to address issues with renewable energy such as those depicted through the "Duck curve". This Report looks at technological innovation cases led by the private sector to understand what the benefits and challenges are in these technologies and how they are commercialized and integrated into the current system.

Sustainable Finance Creating a New Asset Class



This section discusses how the financial sector can and should facilitate the transition. Investors have more than adequate funds under their management to help drive the green transition. However, a lack of understanding on the physical, climate and economic risks associated with the transition and the lack of track records or past performance to gauge future performance is a disconcerting factor for investors. There is a need for innovative financial instruments such as carbon credit markets and carbon taxonomy, support from the public sector, and increased disclosure from companies on how their business strategy is going to be reducing emissions. This Report looks at two case studies of Green Climate Fund (GCF) and Korea Investment Corporation (KIC) on how they plan to diversify their capital sources through financial innovation.

Climate Risks and Financial Systems



This section explores the risks and uncertainties to financial institutions in the low-carbon transition and how wastage from financial investments in heavy carbon infrastructure that is no longer needed can be minimized. These risks could be mitigated through climate stress tests that measure the impact of carbon pricing policies and low-carbon technology development on corporate production cost and corporate value added. Some financial institutions have also hired climatologists to improve the scenario analysis. Banks have also been asked to work with other agencies to cover insurance, to look at greenwashing issues, to restrict financing fossil fuel expansion, and to enforce greater disclosure policies by banks and companies.

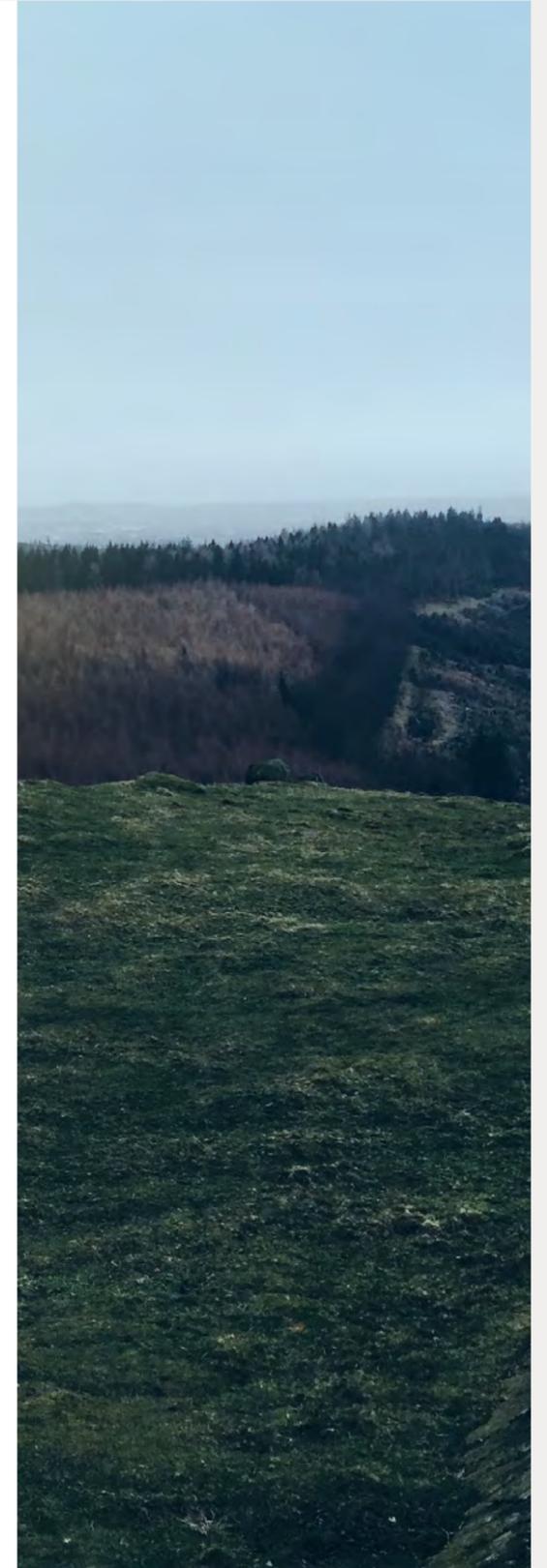
Successful Practices and Strategies for Institutional Transformation in the Asia-Pacific



This section explores successful sustainable finance practices and strategies in the Asia-Pacific that have been implemented and challenges that must be overcome. This report looks at how Green Growth Planning and Implementation (GGP&I) uses thematic green bonds to raise investments in Vietnam and Indonesia and what steps the Asian Development Bank (ADB) is taking to better align their portfolio with international agreements such as the Paris Agreement. While instruments like green bonds can perpetuate issues such as greenwashing, increased disclosures will be critical in alleviating those concerns.

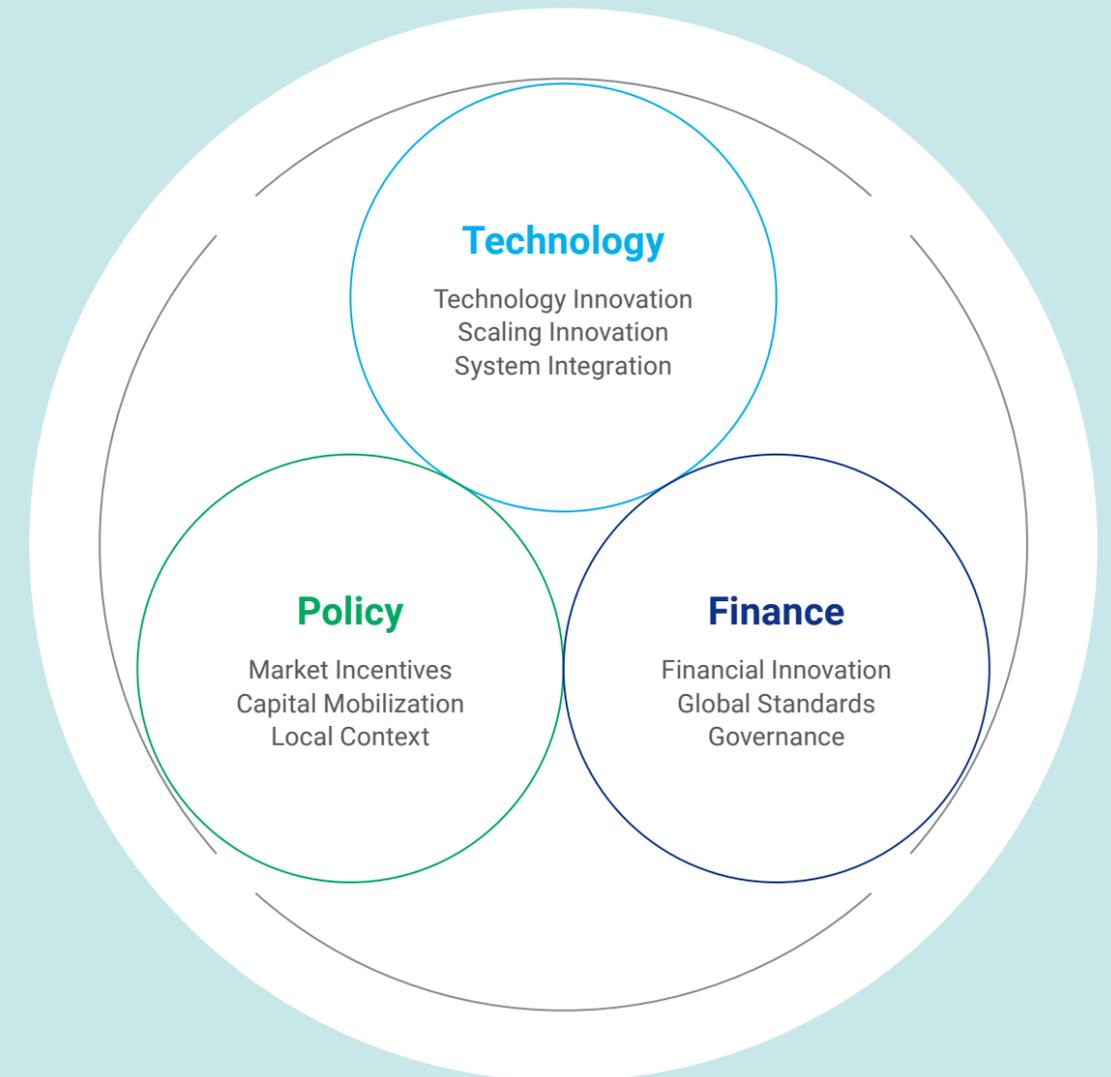
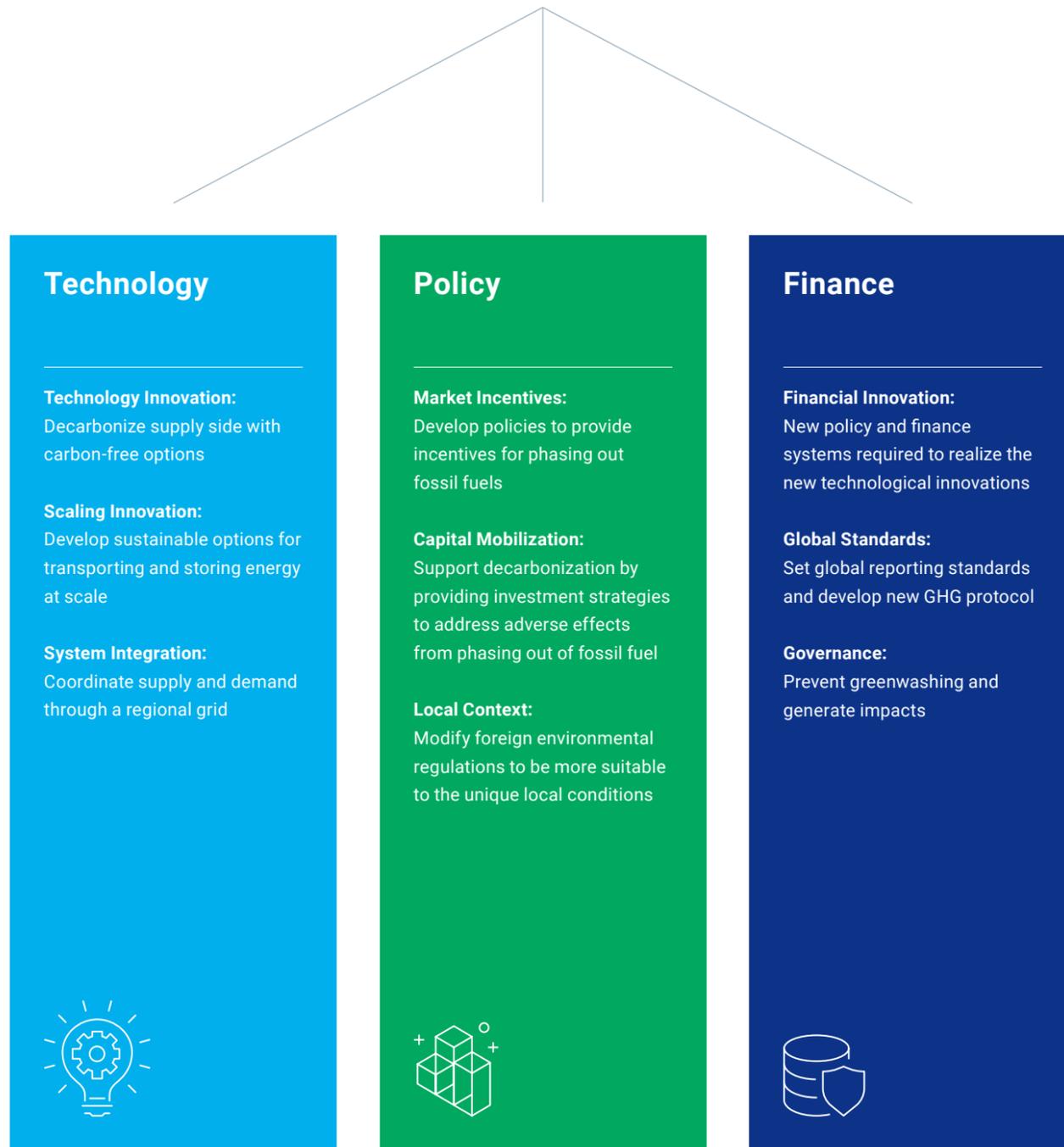
Research Agenda for Asia Sustainable Finance

In addition to identifying the challenges in a low-carbon development pathway, this report also looks at the way forward. This includes changes to the resource base through decarbonizing the supply side to meet the increasing energy demand, integrating cleaner energy sources in the grid, and using energy storage technology to resolve the intermittency issues prevalent in renewable sources of energy such as wind and solar. On the policy front, there is a need to integrate new financial instruments within the workings of economic institutions and to devise appropriate accounting methods in the interest of improving disclosure. Finally, on the technological front there is a need for greater collaboration at the national, private sector and educational institution level, and to leverage locations with more competitive markets and greater experience to drive technological innovation.



Main Takeaways

“Integrated and Coordinated Actions Toward the Sustainability Transition”



Preface



Mark Carney

UN Special Envoy on Climate Action and Finance
Former Governor of the Bank of England (BOE)

“It is clear that Asia will play a critical role in achieving net zero given that it will be managing up to 50 percent of the global investment for the transition.”

The strong correlation between climate and security necessitates an accelerated transition to a more sustainable future. Asia will play a central role in this transition and in safeguarding our livelihoods and our planet. The good news is that the foundations for this transition have been put in place at the recent 26th Conference of the Parties (COP26) in Glasgow. The proportion of emissions that are now covered by net zero country pledges has grown over the course of the last 2 years, from less than a third of global emissions to almost 90 percent. Net zero is now the organizing principle for over 5,000 of the world’s largest companies, and with the right policies, it will become the norm throughout the global economy.

However, the scale of what is required is enormous - emissions must fall 7 percent per year over the course of this decade. In 2020, at the height of the COVID19 pandemic, the world met this high bar, but only because large parts of the economy were shut down. This underscores the need for increased investment in the net zero initiative, which includes doubling the energy infrastructure investment to almost 5 trillion USD per year. While this figure might seem daunting, it is the kind of investment that the world economy needs given its significant scope for creating jobs, its large GDP multipliers and its global impact. The money that is needed for this transformation is increasingly being made available. At COP26, 24 major reforms were pledged at the heart of the financial system to ensure that major financial decisions take climate change into consideration. Some of these reforms have been discussed below.

— Sustainability Reporting Standards

Developing mandatory climate disclosure based on the Task Force on Climate-Related Financial Disclosures (TCFD) so that financial institutions of all types have the information that they need to make informed decisions. This is going to be codified by a new body, the International Sustainability Standards Board (ISSB), which will develop a global disclosure standard. The ISSB has already been supported by more than 45 other nations, representing over 75 percent of global emissions.

— Climate Stress Testing

Taking climate change into account also involves ‘climate stress testing’ by major banks and insurance companies so that they can assess which companies in their portfolios have plans for the transition and therefore manage their risk accordingly. These seemingly arcane but essential changes to the plumbing of finance are moving climate change from the fringes to the forefront.

— Global Alliance on Sustainable Finance

The world’s largest banks, insurers, asset managers, assets owners and financial market infrastructure providers, through the Glasgow Financial Alliance for Net Zero (GFANZ), have pledged a resolute focus on net zero. Over 450 of the world’s largest financial institutions have committed to manage their balance sheets on the path to net zero, which collectively amounts to over 130 trillion USD (40 percent of global financial assets). The Asia-Pacific region currently has over 50 members managing over 16 trillion USD and it is expected that both these numbers will grow significantly in the next few years.

It is clear that Asia will play a critical role in achieving net zero given that it will be managing up to 50 percent of the global investment for the transition. It is, therefore, critical that institutions from around the world, particularly in Asia, form a part of this transition process. The GFANZ is working to develop an Asia-Pacific regional network to increase the representation from Asia in this global conversation and to transition the GFANZ efforts from ‘commitments’ to ‘implementation’.



Preface



Manuela V. Ferro

Vice President of East Asia and Pacific (EAP), World Bank

“Confronting climate change will require a vast expansion of public and private investments in low-carbon and climate resilient economies.”

Climate change is a growing threat that presents two challenges to developed and developing countries alike: The first is to adapt to the impacts of climate change, which can already be seen today in extreme weather events, higher temperatures, rising sea levels, and coastal erosion. The second challenge is to contribute to global efforts to slow down or reverse the warming of the earth's atmosphere, that is, to mitigate climate change.

In the East Asia and Pacific region, even though per capita carbon emissions remain below the OECD average, total emissions have tripled since 2000 due to a combination of rapid economic growth and carbon intensive economies. Moreover, according to the Long-Term Climate Risk Index (CRI), six out of the top 20 countries most exposed to climate risks in the world are in this region. Countries

have made important commitments under their nationally determined contributions (NDC). However, impactful climate action will require significant resources, and financing needs may be higher than initially estimated.

The World Bank has been a longstanding partner for climate action in East Asia and the Pacific, having contributed more than 12 billion USD toward climate finance in the region over the past five years. The World Bank's experience can offer insights in how to mobilize climate finance to make the transition towards resilient, low-carbon economies a success.

—— Financing

The transition will be financed by a combination of public and private sources. The World Bank has developed innovative approaches, including insurance and risk financing instruments such as catastrophe bonds and loans with deferred drawdown options to improve disaster risk management and the financial resilience of countries prone to natural catastrophes.

Public financing is important, but it is also critical to mobilize private sector investment toward adaptation and resilience. This will require conducive policies and reliable metrics to measure impact. There is an increasing pool of private finance that has the potential to flow to climate related investments. There are now nearly 4,000 signatories to the Principles for Responsible Investing (PRI), and this includes some of the world's largest institutional investors with more than 120 trillion USD in assets under management.

To help countries access this capital, the World Bank has been a pioneer in sustainable green bonds. Green bonds have increasingly become mainstreamed as reflected in the Green Bond Principles adopted by the International Capital Market Association (ICMA). To date, the World Bank has issued over 200 green bonds amounting to 18 billion USD equivalent in 25 currencies, of which nearly 6 billion USD for the East Asia and Pacific region.

—— Green Taxonomy

The World Bank is also working to develop a green taxonomy with regulators in countries like Malaysia, Indonesia, Colombia, South Africa and Bangladesh. Green taxonomies will give more certainty to investors looking to place capital in environmentally sustainable projects, providing a stronger base for capital flows into those areas. Lessons from the development of the green bond market can be leveraged to support ocean and coastal solutions and create sustainable business opportunities for a resilient blue economy.

—— Carbon Pricing

Instruments like carbon taxes and emissions trading can guide the allocation of capital and research efforts as economies become greener. As new technologies are developed, price signals will incentivize their diffusion to

the areas of highest benefit. Since 2011, the World Bank's Partnership for Market Readiness (PMR) has supported 23 emerging economies to design and implement carbon pricing instruments. The Partnership for Market Implementation (PMI) was launched in 2021 as a response to the increasing demand from countries for carbon pricing policies to meet their NDC targets. The PMI has an ambitious long-term vision to introduce price signals on carbon emissions across jurisdictions and sectors in order to contribute to the goal of the Paris Agreement of limiting temperature rise to 1.5 degrees Celsius.

—— Decarbonization

Reducing the world's emissions will also require significant investments in clean energy coupled with a phasing out of coal. At present, coal contributes one third of the total greenhouse gas (GHG) emissions and accounts for 60 percent of the electricity consumed in the East Asia and Pacific region. The World Bank estimates that implementing current power sector transition plans in China, Indonesia, the Philippines and Vietnam alone will require cumulative investments of over 6 trillion USD to 2040. A more aggressive decarbonization scenario could require an increase in investments to nearly 9 trillion USD.

—— Towards Greener, More Sustainable Growth

Confronting climate change will thus require a vast expansion of public and private investments in low-carbon and climate resilient economies. This will need policy frameworks that encourage these investments by putting a realistic price on carbon. It will also require more robust social and fiscal protection systems to support households affected by natural disasters and to help workers in sectors impacted by the transformation towards a greener economy. Addressing the challenge of climate change can seem daunting, but a well-managed transition will also be an opportunity to unlock new sources of innovation, job creation and more sustainable growth.

1

Global Net Zero Landscape

As drivers of climate action enter the fourth decade of what has become a multi-stage race, net zero has emerged as the dominant organizing principle. Hundreds of corporations and investors worldwide, together responsible for assets in the tens of trillions of dollars, are lining up for the Race to Zero.

The “Global Net Zero Landscape” section explores both the state of play and a set of directions to help form judgments about whether net zero will carry climate action far enough. Policymakers, academic scholars, and practitioners discuss technological advancement and needed policy and financial interventions.



Global Solidarity and Cooperation for Just Transition



Michał Kurtyka
Former Minister of Climate and Environment in Poland
United Nations Framework Convention on Climate Change (UNFCCC) COP24 President

There are 3 major challenges in achieving net zero: technology; people; and international cooperation.

Technology

The report published by the International Energy Agency (IEA) ascertains that all the necessary technologies to achieve 2030 reduction targets are currently available. However, about half of these required technologies are either present in the form of prototypes or are only useful to the extent of achieving reduction targets until 2030 and not for neutrality by 2050. The first challenge is to channel investment into designing, building, operating, and scaling up these new technologies to achieve net zero. An ecosystem should be created which incentivises private investors to bring profitable technologies to the market, allowing us to not only achieve net zero but to also reward investors through increased profitability. The private sector can be encouraged to fill these technological gaps by combining climate performance with financial performance.

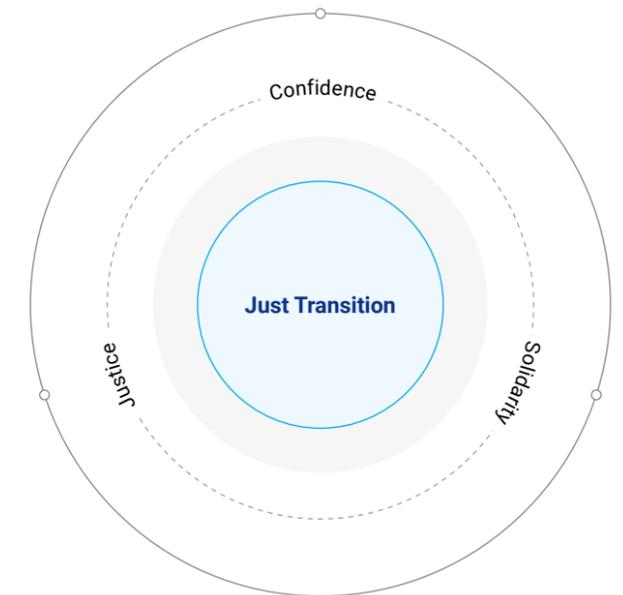
People

In December 2018, there was public outcry across the globe against the marginal increase in fuel cost. This threw light on the fact that climate change and the path to net zero must be viewed through the eyes of every possible social group which will be impacted by this crisis. Some of these groups include workers who would lose employment in the fossil fuel industry or people within the taxation system who will have to bear the cost of the transition on the economy. The concept of 'just transition' is embodied within this recognition.

International Cooperation

Developing countries do not have the necessary technological advancements. The onus is on developed countries to provide funds to developing nations to enable them to procure these technologies. Global solidarity and cooperation is therefore a significant factor in achieving net zero across the globe. A continent like Africa, which is particularly well adapted for solar uptake cannot use electric vehicles because it lacks proper grid infrastructure. Aiding in acquiring these new technologies will also help to create new sources of employment, which can fuel new economic and social dynamics for the continent.

Key themes for just transition



'Confidence', 'Justice' and 'Solidarity' will be the key themes that will drive the global conversation in the energy transition. It will help to bridge the gap between developed and developing nations and will ease the transition to net zero emissions.

Key Takeaways

- The technological challenge in achieving net zero is that half of the required technologies are either present in the forms of prototypes or are only useful to the extent of achieving reduction targets until 2030 and not for neutrality by 2050.
- The challenge in achieving net zero with regard to people is that the transition will create 'winners' and 'losers' and therefore, ensuring 'just transition' and an equitable distribution of the cost from the transition will be crucial.
- Global solidarity and cooperation are significant factors in achieving net zero, particularly with regard to technological and financial support from developed to developing and underdeveloped nations.

Ambitious Net Zero Goals and Timely Implementation



Ali Izadi
Head of APAC Research at BloombergNEF

Indicators for green finance seem to be positive thus far.

Equity Markets

Environmental, Social and Governance (ESG) themed Exchanged Traded Funds (ETF) had a net flow of about 130 billion USD in 2021, which is almost double that in 2020.

Debt Markets

The sustainable debt issuance in 2021 was over 1.7 trillion USD, which is more than double of the 821 billion USD issued in 2020.

Physical Assets

Investment in physical assets, particularly in energy transition technologies, reached about 755 billion USD in 2021. Investment in renewable power plants, energy storage, and technologies increased by about 27 percent since 2020. This is nearly 3 times the amount that was invested a decade ago in 2011.

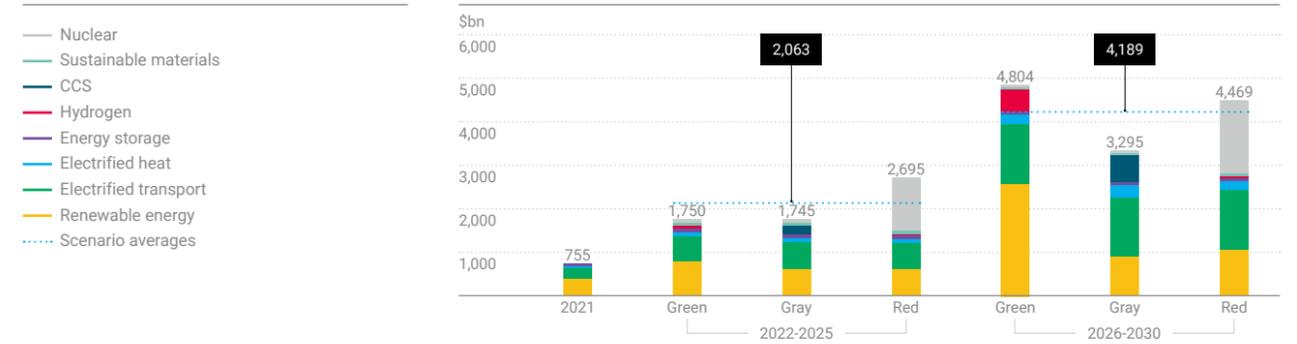
While these investments are positive indicators, the challenge is that the pledges by the countries are too lenient and are focused largely on the destination and not the journey required to reach the destination.

The conversation around setting net zero targets began in 2018 after the Intergovernmental Panel on Climate Change (IPCC) issued their special report emphasizing the need to limit temperature rise to 1.5 degrees Celsius. The report asserted that achieving this 1.5 degrees Celsius goal would be contingent on global emissions being brought down to net zero by mid-century. The report states that by 2030, the emissions have to be lowered by at least 25 percent, relative to 2010, to be compliant with the 2 degrees Celsius goal, and it needs to be brought down by at least 45 percent, relative to 2010 to be compliant with the 1.5 degrees Celsius goal. The NDC targets do not adequately reflect this goal. The report clarifies that even if all the NDC targets are fulfilled, the emissions in 2030 will still be 16 percent higher than emission levels in 2010. Therefore, it is not only the destination that matters but the journey toward that goal.

Even so, many countries are still not setting fairly ambitious 2030 targets. Looking at the top 10 emitters in Asia Pacific, only the 2030 emission reduction targets set by Australia, Japan and South Korea are aligned with what is required for meeting the Paris Agreement goal. The rest of the countries, particularly heavy emitters such as India, Indonesia, China, and most of South Asia, ought to be more ambitious while setting their NDCs. The challenge is that many developing economies are reluctant to make such commitments given the common

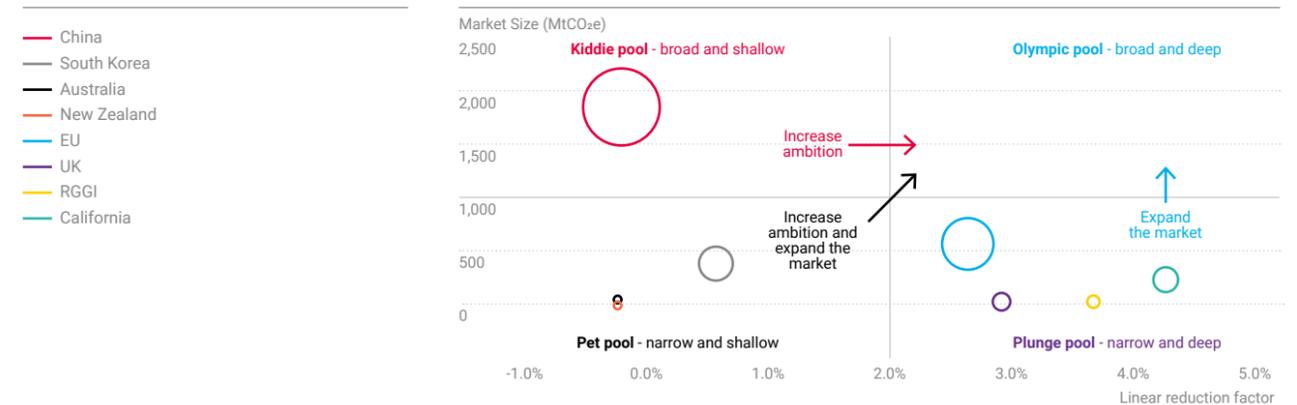
but differentiated responsibilities (CBDR). Developing economies need to be incentivised through greater technology transfer support and more funding to help them make better commitments. Strong political willingness to set intermediary targets and not just long term targets for 2050 is also needed.

Comparison - 2021 energy transition investment versus required annual investment in 2022-25 and 2026-30 in NEO 2021 net zero scenarios



Source: BloombergNEF. Note: Future value are from the New Energy Outlook 2021, except electrified transport, which is from the Electric Vehicle Outlook 2021 Net zero Scenario. Please consult the latter for a description of the Net zero Scenario and the New Energy Outlook for the Green, Gray and Red scenarios. All three 'color' scenarios target global net zero 2050 in line with 1.75 degrees Celsius of warming.

Carbon market size and ambition



Source: BloombergNEF. Note: Size of the circle represent the emissions cap for 2021. The linear reduction factor refers to the annual rate of reduction of the emissions cap compared to 2021. Market size is calculated by multiplying the 2021 cap with the scope coverage compared to the total emissions in the region (%). RGGI refers to the US Regional Greenhouse Gas Initiative.

Key Takeaways

- There are several positive indicators for the green finance market including doubling of the ESG themed ETFs, doubling of sustainable debt issuance and increased investment in energy transition technologies.
- The NDCs declared by countries are not ambitious enough to achieve the goal of limiting temperature increase to 1.5 degrees Celsius above the pre-industrial levels.

Net Zero Scenarios and Models



John Weyant

Professor of Management Science and Engineering

Senior Fellow at the Precourt Institute for Energy, Stanford University

There are hundreds to thousands of net zero scenarios, including, but not limited to those included in the current IPCC Assessment Report. These scenarios are fraught with uncertainties and complexities, and many overlapping areas ranging from current and future technology characteristics, future policies and regulations, behavior of people at firms, and capabilities of institutions to deliver solutions, from markets to governments at all levels to private sector at all levels. More challenging amongst these is the aspect of systems integration, which is often overlooked in bottom-up studies. These include the integration of renewables into the grid, the timing of transition from old technologies to new technologies, and how the existing gas or nuclear capacity can be used to leverage the transition to a sustainable future.

Given all these uncertainties, it is important to undertake a qualitative and quantitative assessment on the finance side and consider a broad range of scenarios. Factoring in for unexpected changes in circumstances will be critical in the transition given that it is often these unexpected changes that dominate the future course. There is tremendous complexity and uncertainty in assessing risks in the transition, both regulatory and fiscal. So, for actionable recommendations to come out of policies, these assessments must come down to the project asset level. Often, the scenarios generated by global and national models do not adequately include financial considerations while choosing technology. They often focus only on the capital requirements to build capacity at a near risk-free rate, rather than on looking at the actual investment in these assets at more risk realistic rates.

The modeling and analysis can help clarify the data we need and the implications of the data we have. These models help in identifying coverage and boundary issues. But there are big challenges with regard to the timing of the transition and even bigger challenges with regard to the obligations that are being made. These models must therefore be applied to be compliant with commitments by turning policies and measures into actual laws for a country or a company.

✓ Key Takeaways

- Net zero scenarios and models are fraught with uncertainties and complexities.
- Accounting for the unexpected will be critical given that unexpected changes often dominate the future course.
- These models and scenarios must be applied to turn policies and measures into actual laws for the country or company.

Geopolitics of Climate Actions in East Asia



Yeon-chul Yoo

Former Ambassador for Climate Change of the Ministry of Foreign Affairs, South Korea

While South Korea, China and Japan are seen as the leaders for climate action in Asia, China's response to climate change will make a major difference since it emits the largest amount of GHGs in the world. Previously, people were apprehensive about China actively responding to climate change, but in this new international order of low-carbon development ushered in by the Paris Agreement, China has clearly indicated its willingness to be a leading nation. While there is tension between the US and China on issues of climate change, both countries are willing to cooperate with each other. China has recently been exporting electric vehicles to Europe. When it comes to renewable energy, China has 5 to 6 of the top 10 companies in the world.

China's actions have an important implication for South Korea as well. China's increased investment in climate efforts has triggered a parallel rise in South Korea's investments and efforts to reduce GHG emissions. In 2021, South Korea announced the Korean New Deal which sought to invest 220 trillion KRW. The Korean New Deal is significant because the priority of climate policy comes from this budget. Investment will be made toward developing future technologies, decarbonization efforts and creating a circular economy required for achieving sustainable industrial innovation.

But the circumstances for carbon response are not favorable because South Korea is a geographically small territory with low potential for renewable energy. This has created a high dependency on coal and trade, which is highly energy intensive. The country also has numerous industries that emit high levels of GHGs, making it difficult for the industrial sector to achieve carbon neutrality. Despite these challenges, the South Korean government is serious about achieving their pledge to reduce GHG emissions and reach carbon neutrality by 2050 by working with the private sector to look for tangible measures. For instance, South Korea is working to develop innovative technologies such as energy storage system (ESS) and battery technologies in its commitment to achieving net zero, which will also help to open more opportunities for South Korea in the global market.

✓ Key Takeaways

- Even though China emits the largest amount of GHGs in the world, it is ushering in the international order of low-carbon development through its investments in renewable energy.
- South Korea has several challenges such as its small geographical territory and large number of high emitting industries that make the green transition particularly tedious. Even so, South Korea is working to develop innovative ESS and battery technology in its commitment to achieving net zero.

2

Sustainability at the Leading Edge of Technology

Countering global population growth and rising affluence and consumption levels, technology is an important component of strategies to reach net zero emissions. More sustainable technologies, which can meet increasing demands for goods and services while emitting fewer carbon emissions, are being created every day by innovators, academics, entrepreneurs, and others around the globe. This Forum explores a host of new technologies that are capable of addressing net zero challenges at a large scale, and on a timeline that responds urgently to the growing climate emergency, and also discusses how they fit within the larger context of building a net zero economy in Asia and other parts of the world.

The “Sustainability at the Leading Edge of Technology” section touches upon several critical technological breakthroughs that would be needed to achieve net zero. This includes long duration energy storage, carbon capture technology and technologies targeted toward the energy sector given that it is the most carbon intensive sector. However, there is a unanimous recognition of the fact that there is no silver bullet to solve this problem. It will require a combination of technological efforts along with social, political and financial institutions.



Catalyzing Key Industries Through Market Incentives



Nok Young Kim

Head of Carbon Neutral Center
Korea Chamber of Commerce and
Industry (KCCI)

When the South Korean government set the carbon neutrality target in 2021, South Korean companies were struggling to come up with a plan to meet this target. There are 680 companies that are operating within the Emissions Trading System (ETS), and 90 percent of those companies came out with a carbon neutrality plan. About 76 percent of the companies aim to achieve the goal by 2050 and 18 percent of the companies could achieve it earlier, while 6 percent of the companies aim to achieve carbon neutrality by 2060. Even though companies are now beginning to view carbon neutrality as an opportunity, there are several other challenges along the road. There is a lack of capital for investment, inadequate decarbonization technology, and a lack of renewable energy infrastructure.

In order to reduce carbon emissions in these industries we need some key actions, some of which have been suggested below.

—— Technological Innovation in the Manufacturing Industry

South Korea's manufacturing industry's energy efficiency level is at the highest level in the world. However, in its path to achieving carbon neutrality, South Korea is only at 80 percent of the European Union (EU) and the US level. In part, this could be attributed to the steel industry which is heavily reliant on coal. A more comprehensive approach would involve changing the production process by transitioning to hydrogen. However, this transition will necessitate a large and stable supply of hydrogen. POSCO and other large steel companies are facing challenges in making this transition because they have to spend about 50 trillion KRW in replacing the existing furnaces. Further, there is a cost of investing in R&D and dismantling furnaces, particularly those which have only reached one third of the operation lifetime. And if there is no stable and affordable supply of hydrogen, that would be another significant risk.

—— Change in the Fuel Sources

Fuel sources would have to be replaced as presently, 50 percent of imported oil is used as an ingredient and not as an energy source. Also, fuels used in the petrochemical industry would have to be replaced with more bio energy, which could be quite challenging. In the automobile industry, internal combustion engines will have to be retrofitted to accommodate electric and hydrogen energy sources.

—— Reforming the Financial Market

This would involve 2 main reforms.

- Presently, South Korean policy is inclined toward smaller companies. For environmental preservation, large companies only receive 1 percent tax deduction, whereas small companies get as much as 10 percent tax deduction. The amended carbon law provides less support to large companies in the transition. Performance based incentives should be given to large scale companies given that they can reduce large scale of GHGs.
- Companies should be encouraged to voluntarily develop their own technologies and initiatives, which would be more effective in achieving carbon neutrality. Markets should be created to incentivize companies to reduce their emissions. It should be seen not as a cost but as an investment for future benefits.

✓ Key Takeaways

- SMEs and large companies will play a pivotal role in South Korea's plan to achieve carbon neutrality.
- Industries hoping to make a green transition will need to make changes in their production process, which includes changes to their fuel sources and innovative technology to make the overall production less carbon intensive.
- Financial incentives and market instruments such as ETS and carbon tax will be crucial in helping companies make the transition.

R&D Strategy to Achieve Net Zero



Hee-Tae Jung

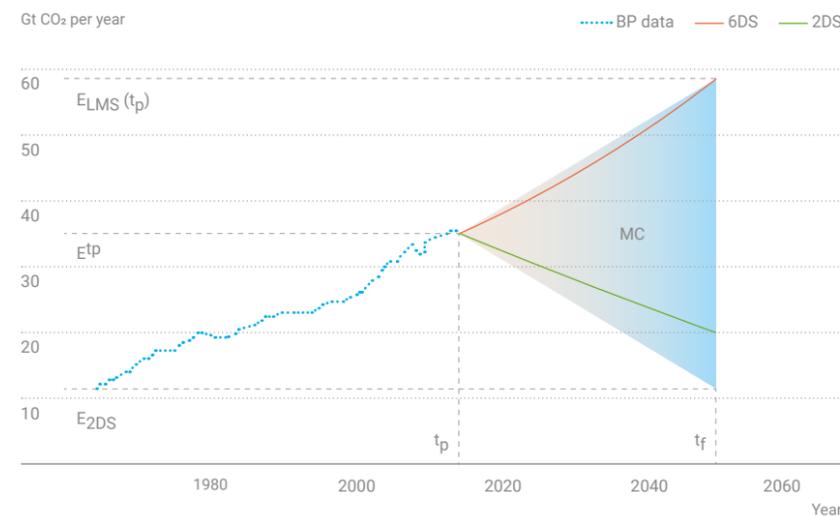
Chair Professor of Chemical and Biomolecular Engineering, KAIST

Director of KAIST Institute for Nanocentury

The Energy Outlook Report¹⁾ published by BP showed that in order to restrict temperature rise by no more than 1.5 degrees Celsius above the pre-industrial levels, the total carbon emissions should fall to 2.5 gigatonnes of carbon dioxide (GtCO₂) by 2050. Therefore, a good R&D strategy is required to achieve this goal. The international strategy to reduce the carbon emissions includes a 32 percent reduction by replacing fossil fuel with renewable energy sources, 38 percent reduction through energy efficiency, 10 percent reduction through carbon capture, utilization and storage (CCUS), and the rest of the reduction being achieved through other technologies.

¹⁾ BP, *BP Energy Outlook 2022 Edition*, BP (2022), <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2022.pdf>

Illustration of the calculation of the mitigation challenge



Source: Mac Dowell, N., Fennell, P. S., Shah, N., & Maitland, G. C. (2017). The role of CO₂ capture and utilization in mitigating climate change. *Nature Climate Change*, 7(4), 243-249.

The situation is not much different in South Korea as well. In fact, it is even more challenging compared to the international reaction to carbon neutrality. Korea Advanced Institute of Science & Technology (KAIST) Institute for NanoCentury examined and reported 10 key R&D fields identified below:

- Green Hydrogen (Fuel cell and new production)
- Solar Cell
- Artificial photosynthesis
- Carbon Capture and Utilization breakthroughs
- Eco-friendly GHG storage technology
- Future Battery with Safety and High Capacity
- Energy Harvesting
- Optimization of Energy Cloud System
- Climate Prediction via Artificial Intelligence (AI)
- Self-generation (Thermo-electric)

However, from an R&D viewpoint, there are so many challenges in order to overcome global warming in this limited time. Some of these challenges include whether renewable sustainable energies are actually sustainable, how to produce green hydrogen without carbon emissions, whether artificial photosynthesis is possible, the effectiveness of sustainable energy, and the possibility of creating low-cost solar cells with high-energy density. In the future, there is a need to develop new 'killer' technologies, which can contribute to the sufficient reduction of carbon emissions.

✓ Key Takeaways

- Restricting temperature rise to 2 degrees Celsius above pre-industrial level will require a good R&D strategy.
- Some of the key R&D fields which could help address the climate crisis are energy harvesting, climate prediction through AI and artificial photosynthesis.

Nuclear Energy for Net Zero

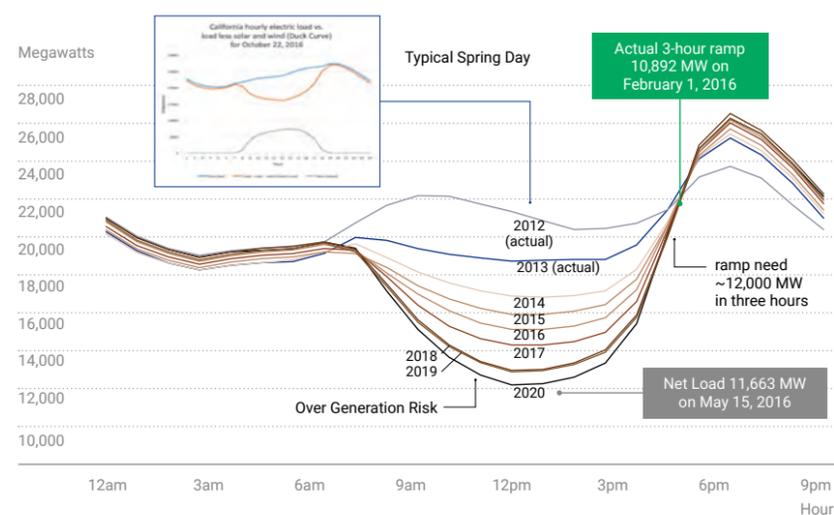


Man-Sung Yim

Professor of Department of Nuclear and Quantum Engineering
KAIST

A large part of our energy consumption comes from fossil fuels that are carbon intensive. Transitioning to a low-carbon economy will require a shift from fossil fuels to renewable energy, such as solar and wind. However, these renewable sources have certain limitations: first, they are low density energy sources and therefore require a large land area to harness adequate energy; and second, the intermittency of renewable sources decreases the quality of electricity, and the stability of the electric grid. This intermittency and the challenges that result from it are reflected in the 'duck curve'. During the day, it is easy to harness solar power and therefore, there is lesser reliance on other sources of energy. But as soon as the sun goes down, there is a steep increase in the demand for energy from other sources within the electricity grid.

"Duke Curve" due to large increase in variable renewable energy (VRE)



In the case of California or countries like Germany, they have neighbors who can provide that needed electricity during the ramp up. But this is not feasible for island countries like South Korea. For such cases, ESS will play a key role. While current innovation is focused on energy storage systems with a capacity of hundreds of megawatts, transition on a nationwide basis will require gigawatts worth of storage. ESS on such large scales presents cost and safety issues. Frank Endres, professor at Technische Universität Clausthal, clarifies that energy transition without an energy storage system is technically impossible but energy transition with an energy storage system is economically impossible, at least for the foreseeable future. Nuclear energy presents opportunities to address these issues of solar energy. Its high energy density provides an opportunity for energy security with fuel storage. The benefits and drawbacks of nuclear energy have been described below.

Benefits:

- In many cases, the process involves extracting the energy using neutrons, and not using oxygen or chemical energy. As a consequence, there is no emission of carbon dioxide or GHGs.
- A large quantity of energy is generated through nuclear energy, which is beneficial for rapidly developing industrial nations, such as South Korea.
- Nuclear power being used for electricity generation as well as non-electricity generation would significantly reduce the GHGs being emitted.

Challenges:

- Complex technology needs to be developed to extract and store lesser quantities. At present, the nuclear reactors that are being built are required to be large to facilitate storage. But this poses serious problems for countries that do not have enough size for the electric grid, or that cannot accommodate large nuclear power plants.
- The generation of nuclear energy is accompanied by the emission of radioactive materials, which have the potential for large-scale damage to the environment and human health.
- It requires large capital cost, high financial risk.
- It is an inflexible energy source and therefore, can often only be used as the baseload for it to still be cost-effective.

Nuclear power has evolved over the years. We are now in the third generation and moving toward the fourth generation. Evolutions in the design and system have caused a paradigm shift in the use of nuclear power as follows:

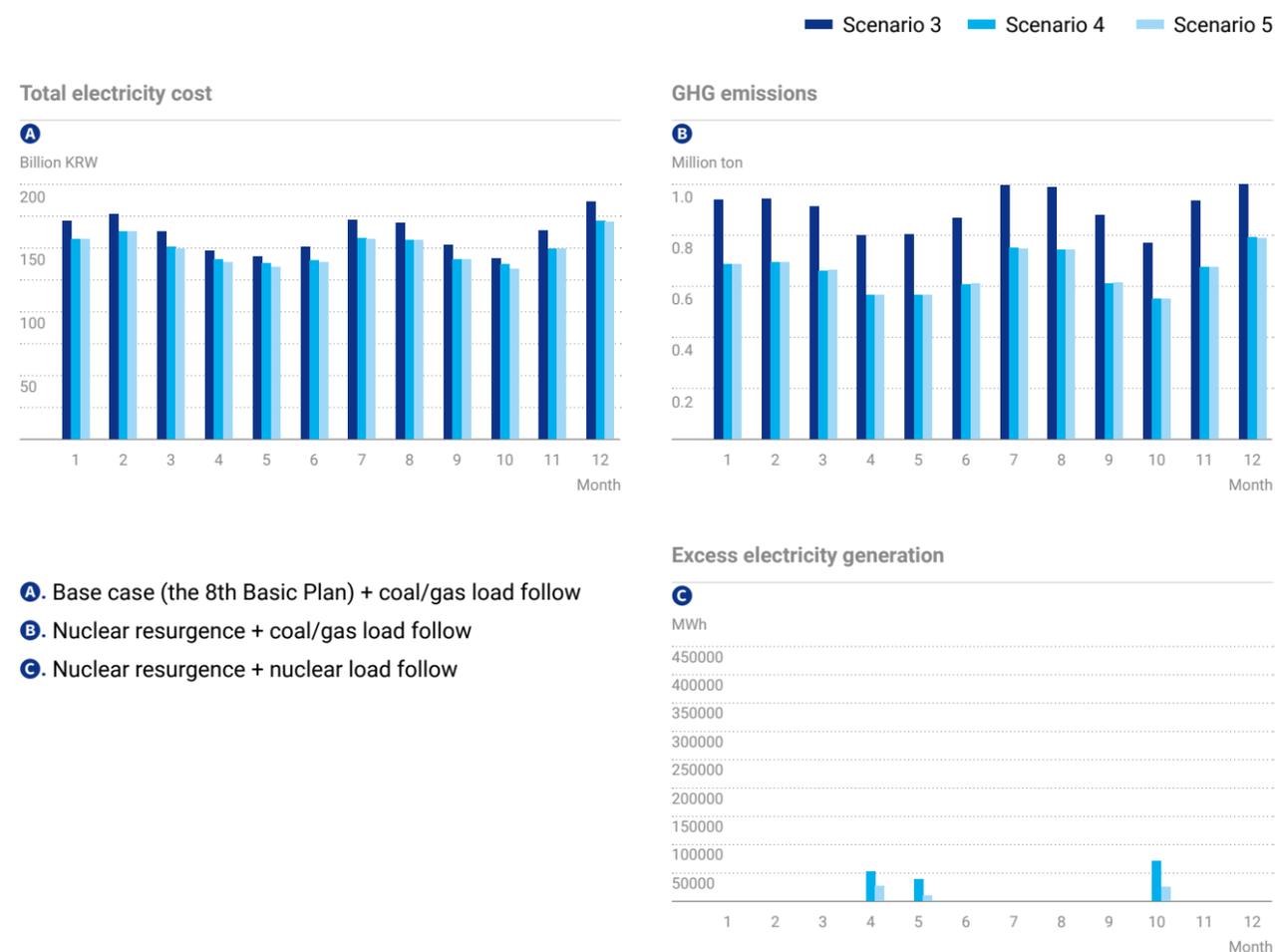
- Transitioning away from large and toward small reactors (<300MW) which are quicker to build and have lower financial risk.
- Creating negative feedback mechanisms or passive safe systems to encourage safer generation of nuclear energy. It can provide a way to practically eliminate the risk of severe damage to the reactor core and the consequent potential for a large release of radioactive materials. Having these safety systems in place could significantly reduce hurdles in production zone planning.
- Production of alternative energy vectors. This involves using the heat from nuclear power and channeling it for district heating, desalination and other industrial processes. Steam from the process can be separated and used for other purposes besides energy generation. More than 17 countries are already doing this.
- Technologies have been developed to separate the problem radionuclide from the waste generated from nuclear power. South Korea is currently developing this technology where the separated radionuclide can thereafter be used as fuel for energy generation.

Public acceptance is a challenge while using nuclear power. But Small Modular Reactors (SMR) are a potential game changer in this regard as it provides higher profits with a shorter construction time. Small grids in remote regions can also accommodate these SMRs given their site flexibility.

Countries that were previously reluctant to invest in nuclear power are now joining the SMR market. These markets are particularly growing in Asia, especially in South Korea, China, and Japan. They are all very active in terms of developing SMR assemblers with various applications in mind, including alternative energy vectors.

Aside from site flexibility, the question is whether nuclear power can be cost effective or competitive in producing alternative energy. This question is often posed because of the excess electricity produced during nuclear generation. The cost of renewable energy is 7.85 USD per kilogram. But by using different technologies and variations in storage and transportation, we could bring down the cost even further. Innovation in technology enables a paradigm shift, especially in the nuclear sector, which facilitates the transition to carbon neutrality.

Comparison of cost, GHG emission, and excess electricity generation under different scenarios in ROK



- A. Base case (the 8th Basic Plan) + coal/gas load follow
- B. Nuclear resurgence + coal/gas load follow
- C. Nuclear resurgence + nuclear load follow

Key Takeaways

- Nuclear power has several benefits and challenges. Redesigning the nuclear power generation system through advancements in technology will help to limit the challenges including those concerning storage, waste production and safety.
- Small modular reactors will be the game changer given their site flexibility, low capital cost requirement and high profitability.
- Nuclear power can be cost effective and competitive, more so with innovation in technology.

Case 1

Breakthrough Technologies Developed at University Labs

Source: Yi Cui's Lab- Yi Cui, Director, Precourt Institute for Energy & Professor of Materials Science at Stanford University

Professor Cui and his team have been undertaking innovative research and development in sustainable technology. Some of the companies formed by the team and their respective field of impact have been listed below.

Amprius- High Energy Batteries

Amprius has created the highest energy density batteries in the world. High energy density lithium ion batteries were invented by his lab nearly 15 years ago. Lithium-ion batteries are used in electric cars due to their low cost and high energy density. The capacity of these batteries can be further developed with the help of nanotechnology. Silicon nanowires and nanoparticles could help overcome the material challenges with lithium-ion batteries such as those relating to volume expansion and contraction when large quantities of lithium are stored. While this has been successful given its application in Airbus, technological innovation is still required to integrate solar and wind into the electrical grid. Solar and wind are intermittent sources of energy and therefore, they require large scale stationary storage to stabilize the grid during the load shifting. The

limitation of lithium-ion batteries is that they can only be used to store energy for up to a few hours and are unable to adapt to the need for seasonal storage. Lithium-ion also has a significant challenge of safety as there have been several accidents while using lithium-ion for stationary storage in South Korea. 5 years ago, Amprius created nickel hydrogen gas batteries to address some of the drawbacks of lithium ion batteries in that they are extremely safe with a long lifetime. The cost is low and it can be sustained in minus 40 degrees Celsius and even go up to 60 degrees Celsius. Amprius plans to build a gigawatt storage facility using this technology.



4C Air- Air Filtration System

This was formed in the midst of the COVID19 pandemic and it uses nanofibers to separate particulate matter from the air.



Eenotech- Technology Accelerator Company

Their contributions are in large scale energy storage to integrate solar and wind into the grid, thermal textiles, water filtration technologies and those for soil clean up. Every year, about 13 percent of the total energy consumed is used toward cooling and warming buildings. Changing the AC set point by 1 degree Celsius, will result in 10 percent energy savings and similarly, changing the set point by 2 degrees Celsius will result in 20 percent energy savings. But changing the set point requires regulation of body temperature. Cooling and warming textiles allow heat to dissipate and so they can be used to cool and warm the body, which can save a lot of building energy consumption.



Case 2

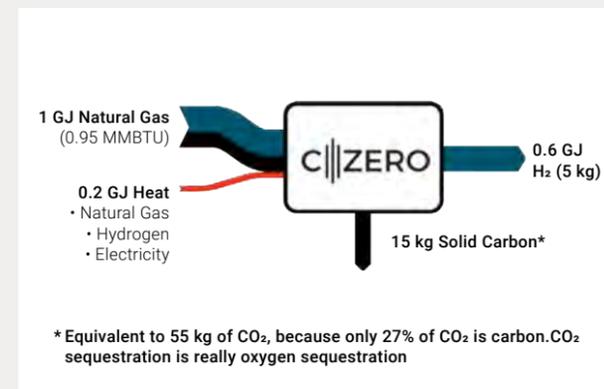
Hard-Tech Startups Getting into the Market

Source: Zach Jones, CEO, C-Zero

C-Zero is a company that focuses on extracting hydrogen from hydrocarbons. About 60 percent of the energy from natural gas, particularly in methane, comes from hydrogen. Being able to separate the carbon and hydrogen could have significant opportunities, given the scale of the natural gas infrastructure, not just in the US, but globally. The carbon that is separated is solid and replaced with sequestered and therefore, this process can be viewed as pre-combustion carbon capture. It is therefore unlocking a zero emission potential for natural gas. Some of the benefits and challenges arising from this process have been detailed below.

Benefits:

- The separated carbon can be possibly used in other markets. While such a market has not already been developed, there is increasing confidence in the need for such a market.
- Methane pyrolysis takes 86 percent less energy per unit of hydrogen produced in comparison to water electrolysis. So it is thermodynamically much easier to liberate hydrogen from carbon than it is to liberate hydrogen from oxygen.
- Changing the feedstock to renewable natural gas, where the carbon did not come out of the ground but came from biomass, could make the process go from being carbon neutral to being carbon negative.

C-Zero's process**Challenges:**

- A significant amount of energy is being left behind in the form of the solid carbon by not turning that into carbon dioxide. But if the feedstock is 1 gigajoule of natural gas, then 15 kilograms of solid carbon is generated in comparison to the otherwise 55 kilograms of carbon dioxide that would have been produced. It is relevant to note that carbon dioxide is over 70 percent oxygen and so when transporting carbon dioxide, most of what is being moved is not something that you really care about sequestering.

Case 3

Large Energy Companies Leading into Energy Transition

Source: In-Sub Jung, CEO, Hanwha Energy Corporation

Hanwha Energy Cooperation is a global energy company based in South Korea, operating across the value chain from project development, which includes cumulative energy like grid management, to electricity retail. In the past 15 years, Hanwha Energy has been rapidly transforming its business portfolio and has been constantly adapting to the changing environment, particularly in the clean energy space. Some of these innovations have been detailed below. The company's strategy and experiences are focused toward achieving net zero.

Solar Energy

Hanwha Energy realized early on that the use of coal results in the emission of carbon and many other pollutants, which cannot be avoided. Recognising this, the company began to invest in solar energy. Today, Hanwha Energy has a presence in 11 countries, including the US and Japan, where cumulatively it is producing more than 13 gigawatts of solar power. However, along the way Hanwha Energy learnt that electricity produced from solar energy also poses a few issues in that it can sometimes be unpredictable or that it has intermittency issues, which can be a burden on the grid. So in the process of developing solar energy they also developed ESS to aid in the stabilization of the grid. Integrating solar into the grid would require such additional efforts to ensure that electricity is available to all the consumers and users.

Green Hydrogen

In addition to solar, Hanwha Energy has also worked toward building about 200 megawatts of hydrogen power plants in Ireland. One of the unique features of these hydrogen power plants is that byproducts of the petrochemical plant are used for generating power. Hanwha Energy is the first company in the world to use byproducts for electricity production. This method of production is consistent with the path for green hydrogen and it is for this reason that Hanwha Energy has been focusing on accumulating experience in developing green energy.

LNG

LNG is another sector being developed by Hanwha Energy as it only produces about 50 percent of carbon dioxide compared to coal. Hanwha Energy's LNG development project is not only being undertaken in South Korea but is also being introduced in Vietnam. Transitioning to LNG will result in carbon emissions being reduced by half, but mixing it with hydrogen could further reduce emissions by 75 percent in the long-term. Advancements in technology could one day make it possible to reduce emissions to 100 percent.

3

Sustainable Finance Creating a New Asset Class

Innovative technologies should overcome the valley of death, continued incentives to fossil fuel-reliant industries, and widening funding gaps, which require cooperation from finance and policy. Yet, the current system frequently fails to mobilize funding from multiple capital sources to sustainable companies and projects because their incentives are misaligned. The outstanding challenge is finding out how to recognize sustainability as a financial value in desired conditions (e.g., form of return, rate of return, time horizon).

The “New Asset Class” section discusses how the financial sector can and should facilitate the transition. This section comprehensively covers perspectives of central banks, multi and bi-lateral development institutions, and investment banks on sustainable finance. The discussion focuses on mobilizing funding from multiple capital sources and the outstanding challenges such as aligning incentives of multiple stakeholders and meeting sufficient financial performance through the new way of investing.



How to Mobilize Long-Term Capital into Sustainability



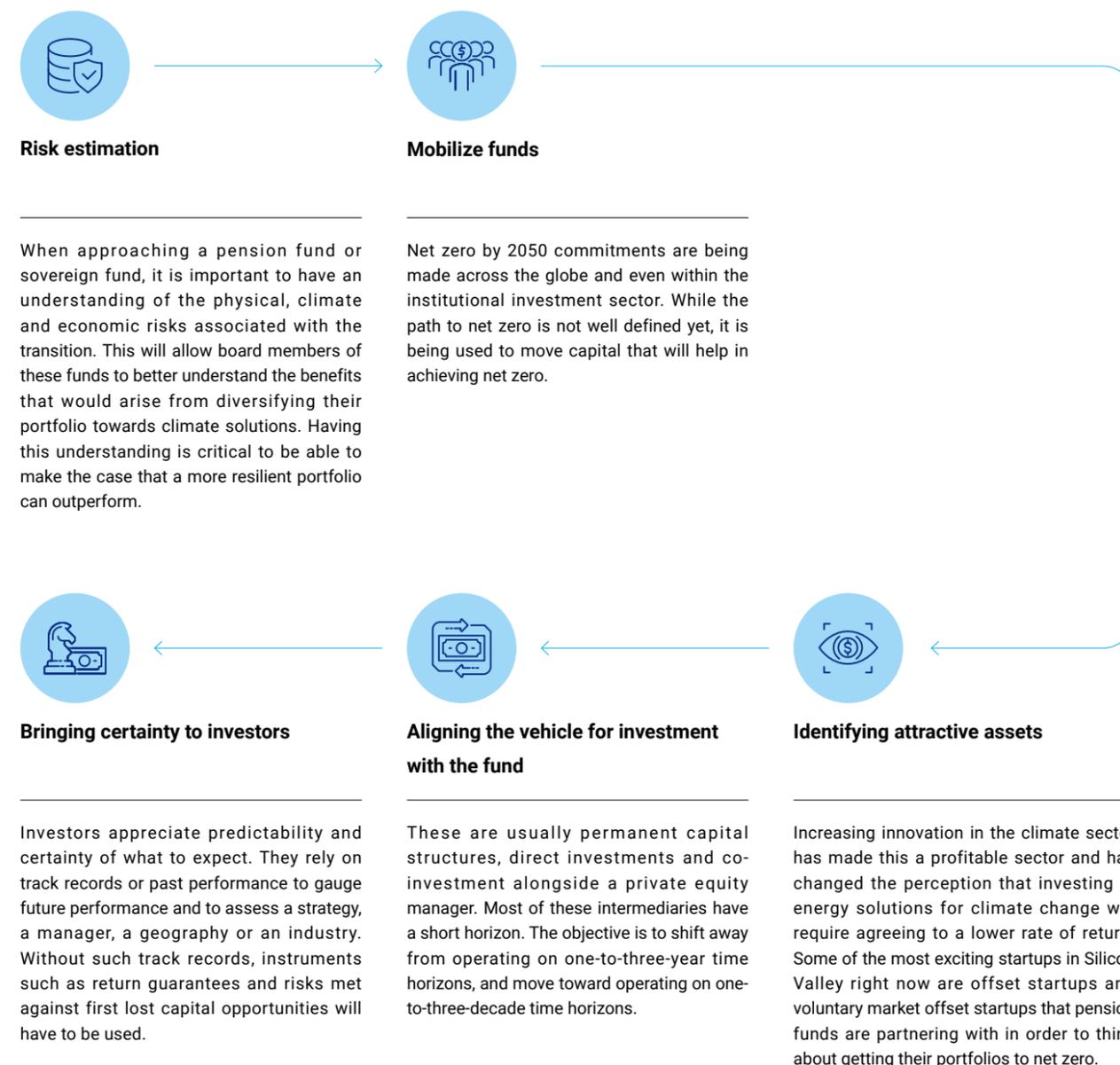
Ashby Monk

Executive Director
Stanford Research Initiative on Long
Term Investing (LTI)

It is estimated that we will need 4.5 trillion USD of capital to support climate solutions and avoid the most catastrophic effects of climate change. Even though investors have 100 to 150 trillion USD under their management, for profit corporations have largely been unavailable or unable to invest at the scales and timeframes needed. Governments are also reluctant to borrow capital to invest in this space, but this is largely attributed to the fact that they are dealing with big debt burdens from the COVID19 crisis. Therefore, the world's politicians are looking to this community of long-term investors.

Long-term investors are intergenerational investors in that they have liabilities extending to 10, 20, even 100 years. While some funds might have such explicit liabilities, others are intergenerational by design in that the liabilities that they carry are implicit. Many of these are sovereign funds and so they have a large spending potential. These sovereign funds, however, have a social mandate, which requires them to pay pensions, fund educational institutions and bolster the state. Often efforts to address climate change are not considered within this social mandate. Integrating climate considerations within this social mandate is challenging given the design of sovereign funds to be conservative and averse to creativity.

Therefore, there are 5 key components that we need to consider when mobilizing their capital.



Key Takeaways

- Long term investors or intergenerational investors will play a key role in financing efforts to tackle the climate crisis.
- When mobilizing capital, one has to consider what the potential risks are, which assets make prudent investments and how investors can be incentivised to operate on longer term time horizons.

Policy Levers to Incentivize Sustainability Integration



Michael Sheren

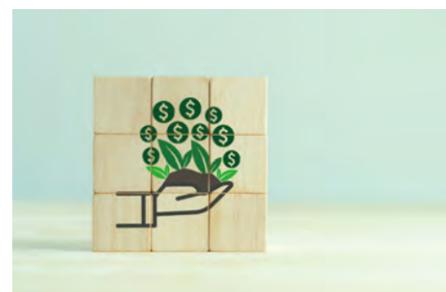
Senior Advisor, Bank of England (BOE)

Co-Chair of the G20 Sustainable Finance Study Group

Carbon is the most obvious free riding externality to the climate that stems from any process. This means that they are negative implications that are a byproduct of a product or a service. These externalities are often not reflected in the products. Policy levers and incentives are required to change business models to make them more sustainable. Some of these policy levers have been detailed below.

Carbon Pricing

In June last year, the IMF came out saying that some type of carbon pricing and carbon tax would be an important initiative to catalyze businesses. This stand has been echoed by the Ministers at the G20 last year and by the OECD. In order for this to work, efforts will have to be made to put a price on carbon and similar free riding negative externalities. Changes could be made to the income statements prepared by corporations where a carbon line of expense could be added within the cost of goods sold (COGS). This could be a significant policy lever given its implications on the free cash flow and on the margins. All of a sudden, returns could be quite similar in some cases for some sectors, and maybe even worse in others. Including this carbon price helps in comparing apples to apples and oranges to oranges, in understanding what a sustainable company looks like and the costs around that.



Carbon Taxonomy

In the field of taxonomy, some of the work is with regard to the TCFD, which helps to provide information and guidance on the path to carbon neutrality. However, there is a need for stronger levers and incentives. One of the big discussions that's going on in the G20 this year is around transition finance, and how the heaviest carbon emitters that are absolutely essential to the economy can be financed. It's going to be a critical area of finance, for multilateral banks, investment banks, venture capitalists and private equity.



Carbon Credit Markets

Recent discussions have been focused on the idea of 'net zero' emissions. The word 'net' implies that emissions have to be set off against something else. This need to balance has given rise to the carbon credit market, which is developing, but is still a long way from being fully developed. It certainly needs serious pricing that's consistent with what is a carbon credit. There needs to be a clear and transparent methodology on what counts as a carbon credit. A registry needs to be created to validate carbon credits and ensure that they are not being double counted. It could be argued that this is another area that's very ripe for coordination among countries and around the private sector and which needs serious regulations. Net zero carbon cannot be achieved unless there is a consistent definition of carbon credit.



Key Takeaways

- Changes should be made to the way products are priced such that carbon emissions, which have been free riding externalities, are reflected in the price of products.
- The carbon credit market needs to be developed with serious pricing policies and a clear and transparent methodology on what counts as a carbon credit.
- The implications of net zero transition on sectors such as agriculture, real estate and mobility will have to be considered and funding must be directed toward these sectors to ease the transition.

Public Finance Supporting the Government's Net Zero Target



Wook-sang Ahn

General Manager of ESG-New Deal Planning Department
Korea Development Bank (KDB)

Finance will play an important role in paving the way to net zero. Korea Development Bank (KDB) recognises this and is committed to functioning as a climate bank to support South Korea's transition. This transition would involve a shift toward low emission processes, particularly in South Korea's carbon intensive industries like steel, cement, and petrochemicals. There have been innovations in this field that facilitate this transition such as the use of a new hydrogen reduction (HyREX) process to decarbonize the steel industry; a substitute fuel being used in the cement industry; and a new biowaste process being introduced in the petrochemical industry to improve energy efficiency.

Even so, there still exist several challenges in this transition, 2 of which have been explained below.

Energy Sector's Overreliance on Fossil Fuels

The energy sector is highly dependent on fossil fuel in power generation, and is therefore poised to be one of the biggest industrial sectors to be decarbonized according to the scenario for carbon neutrality by 2050. In order to achieve net zero, renewable energy needs to account for over 70 percent of the total power generation in Korea by 2050. At present, renewable energy only made up 6.6 percent of the total power generation in 2020. While reliance on fossil fuel needs to be reduced to zero to achieve net zero, it is currently over 60 percent.

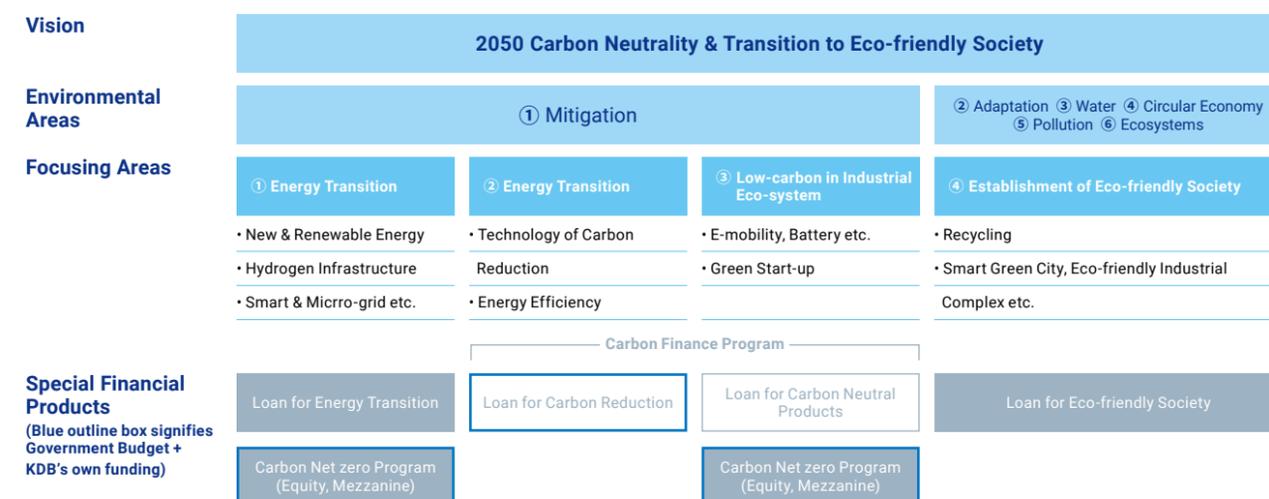
Need for Financial Support

Decarbonizing these large industrial sectors will necessitate a significant amount of investment. According to KDB's internal survey, more than 234 trillion KRW of investment would be required only for the energy transition by 2030. Additionally, the private sector is showing risk aversion to decarbonization investment at the initial stage of commercialization. These concerns can be alleviated by:

- Creating more favorable financial terms and conditions for companies to decarbonize their business.
- Reducing financing risk and bridging the funding gap by permitting the public sector to take more risks by providing equity or mezzanine.
- Encouraging the public sector to provide financial support for companies throughout the stages of R&D and take steps to overcome the so-called "Death Valley".

KDB's Climate Finance Framework

- KDB's Climate Finance Framework Aligned with Korea's Carbon Neutrality and Environmental Goals in K-Taxonomy
- Drive KDB's Financial Support to Increase Green Sectors up to 16.8% by 2030



KDB set up the Green Finance Framework to support the South Korean government's 2050 carbon neutrality target. This is also aligned with the recently established K-taxonomy. Under this framework, KDB has selected 4 focus areas.

- **Energy transition:** new and renewable energy, hydrogen infrastructure, smart and microgrid, amongst others
- **Decarbonization in industrial processing:** carbon reduction technology and energy efficiency
- **Low-carbon in industrial ecosystems:** e-mobility, battery, and green start-up
- **Establishment of eco-friendly society:** recycling, smart green city and eco-friendly industrial complex

Furthermore, special financial products are being introduced to support individual focus areas in a strategic manner. These special products will be supported by the government budget, in addition to KDB's own funding.

Key Takeaways

- Financial institutions will play a key role in the transition and so more favorable market conditions should be created to limit financial risk and ease the decarbonization process.
- Efforts should be targeted toward carbon intensive industries such as steel, cement and petrochemical manufacture. This includes transitioning away from fossil fuel based energy sources and decarbonizing the industrial processes involved.

Major Shifts in Banking and Financial Services



Stella Saris Chow
Head of Sustainable Finance International, ANZ

Subsequent to the Paris Agreement, there has been increased scrutiny and accountability for climate finance. Long-term investment funds have been asking commercial banks, such as ANZ, to disclose their exposure to high emitting sectors and to be transparent on how they are effectively managing their exposure to climate risk. More recently, central banks and banking regulations are asking specific questions around emissions and requiring climate scenario testing. Similarly, banks are also asking their customers, especially those in the energy sector, to disclose Paris-aligned business plans, to communicate how their business strategy is going to be reducing emissions and whether any future investment is aligned to the Paris Agreement goals.

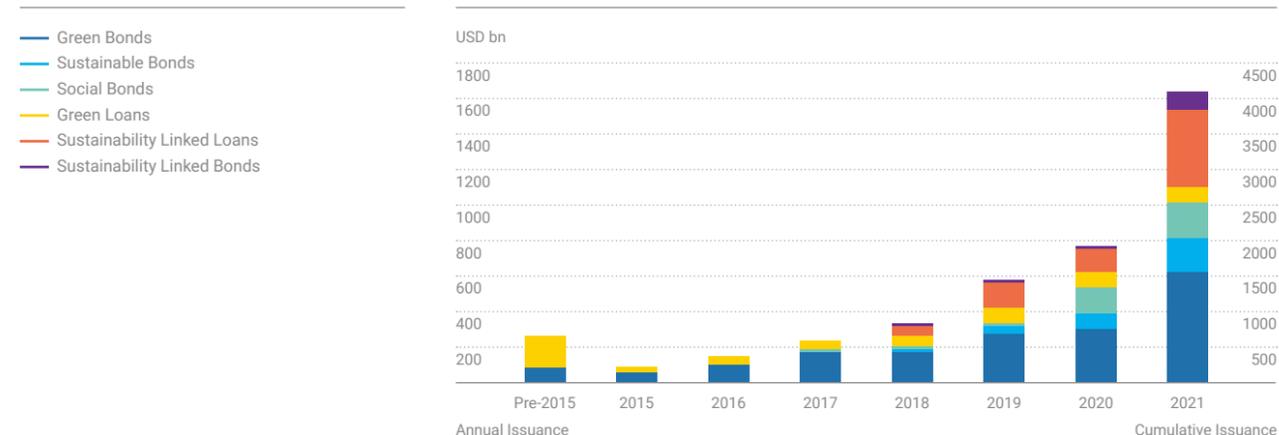
So financial institutions are changing the mix of their loan portfolios in support of low or zero emission technologies over heavy polluting projects or commodities. In addition to financial support, banks are also providing advice to support customers to shift to low-carbon business models and operations that put them on a path to net zero.

These initiatives are made possible by institutional reforms in the banking system, some of which are mentioned as follows.

- The creation of dedicated sustainable finance teams that are equipped to provide advice on green finance and sustainable finance.
- Hiring technical ESG experts, who are not bankers, to evaluate Key Performance Indicators (KPI), to look at a sustainability strategy and to identify the difference between all the various policies and operations.
- Prioritizing investment opportunities for companies with emission reductions targets, green assets or sustainable assets or sustainable bonds. Certain banks internally price transactions at a discount if it goes to a green or sustainable purpose as they look to shift their portfolios.
- Increased investment that will encourage technologies that enhance low emission transportation, green buildings, and development projects such as reforestation projects and indigenous land management practices.

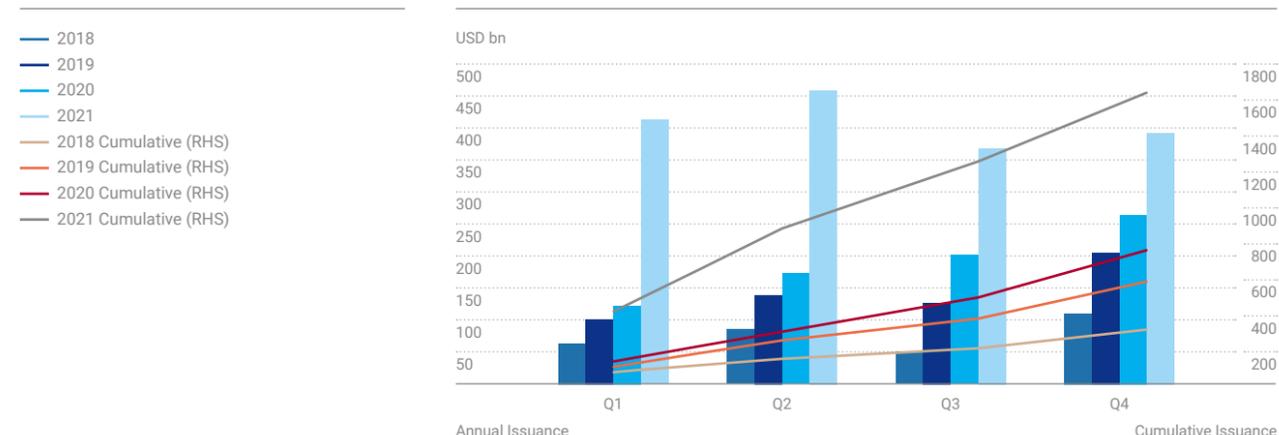
The market has significant potential for sustainable investment projects. The challenge is in finding good quality and commercially viable projects. The market has generated a high degree of innovation in sustainability and the growth of the sustainable finance market is reflecting the underlying investments in these projects. Over time, this sustainable finance market will continue to grow and diversify.

Global sustainability debt market seeing exponential growth



Source: Bloomberg, 31 December 2021

2021 Quarterly sustainable finance issuance



Source: Bloomberg, 31 December 2021

Key Takeaways

- Subsequent to the Paris Agreement there has been a shift in banking and investment funds toward greater scrutiny for climate finance and increased opportunities being provided to companies to facilitate a green transition.
- Specialized sustainable finance teams are being created and technical ESG experts are being employed to cater to the increase in green finance.

Case 1

Korea Investment Corporation (KIC), Sovereign Wealth Fund Integrating Sustainability

Source: Hoon Lee, Head, Investment Strategy & Innovation Division,
Korea Investment Corporation (KIC)

KIC is the sovereign wealth fund of South Korea investing about 100 billion KRW globally. About 82 percent of that is in traditional assets and 13 percent in property, private equity funds and infrastructure or other alternative assets. The NDCs submitted by various countries at COP26 showed that fulfillment of these commitments would result in 2.5 to 2.9 degrees Celsius temperature level rise until 2100, which is not compliant with the 1.5 degrees Celsius limit set by the Paris Agreement. Given this circumstance, the question is how KIC should change its portfolio to support the net zero target.

Diversifying Their Portfolio

KIC has committed 70 to 80 percent of its time and resources in efforts toward climate action. Public funding like pension and sovereign funds have two priorities. First, to achieve stable profits; and second, to respond to social and political demands. KIC recognizes that if portfolios are not diversified to include carbon emission reduction, they would be exposed to higher risks and vulnerabilities. The strategy to account for this change boils down to two approaches, bottom-up and top-down. The bottom-up approach refers to individual assets, such as stocks, bonds, private equity, real estate, or infrastructure.

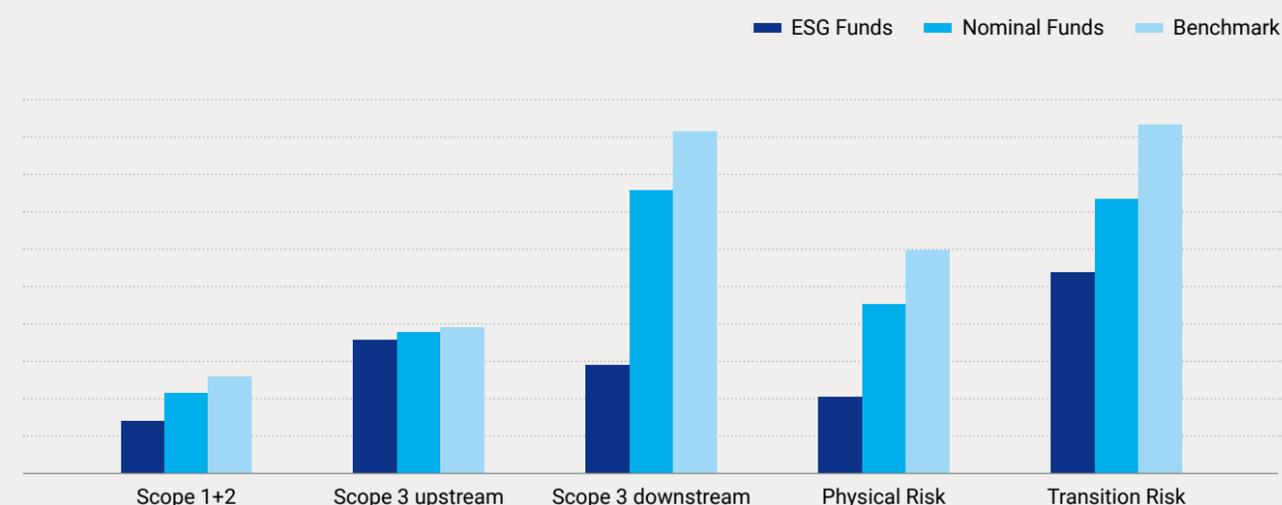
Encouraging Investments for ESG Projects

Last year, South Korea's Ministry of Strategy and Finance issued 500 million EUR of bonds mainly dedicated to ESG projects. KIC has responded to this by creating an ESG dedicated fund. KIC has actively changed its portfolio by encouraging investments solely dedicated to ESG projects and excluded industries that are causing ESG problems from the portfolio. In doing so, it is also examining the risk arising from these changes, and analyzing various scenarios to see the impact on their profitability and growth sustainability.

Green Bonds

The Bloomberg Global Aggregate Bond Index shows that the market for green bonds is growing fast. In the corporate bond market, the sustainable development related bonds were 480 billion USD in 2020 but now it has increased rapidly to about 1.1 trillion USD. The volume of investment is increasing quickly to meet the carbon neutrality target, and the valuation of the funds is also rising. The challenge would now be to assess what level of profit can be achieved through this market and how to encourage companies such as Shell, to move away from investing in oil which gave them substantial profits, and toward renewable energy.

Illustrative carbon intensity & climate VaR example



Source: KIC, MSCI (graphs are for illustrative purpose only and may not be accurate)

Case 2

Green Climate Fund (GCF), Largest Multilateral Climate Fund

Source: Henry Gonzalez, Deputy Executive Director,
Green Climate Fund (GCF)

Green Climate Fund (GCF) is the largest climate fund set up by a multilateral organization (UNFCCC). Their mandate is to work in both adaptation and mitigation, supporting only developing countries with a focus on African states, small island states and the least developed countries. They are a country driven fund, so there is a board that represents both developed countries, who are the donors, and developing countries, who are the recipients. They are an open partnership organization, which means that they do not make direct investments but instead work through asset managers, commercial banks, governments, nonprofits and non-governmental organizations (NGO). As of Q4-2022, GCF's portfolio comprises 209 projects and programmes and stands at 11.3 billion USD in GCF resources and 42.4 billion USD with co-financing. Some of the distinct features of GCF are discussed below.

Asset Agnostic

GCF uses varied market instruments including grants, loans, subordinated debt, venture capital, private equity, green bonds, blue bonds and more.

Encourage Innovation

GCF aims to use innovation to de-risk certain sectors in order to crowd in investors that are both institutional and retail.

Balanced Fund

GCF balances both adaptation and mitigation efforts and works in different sub-sectors of climate change. They are long-term investors, patient capital and risk takers. They are working on the energy generation and access to energy, mobility and transport in cities and industries, as well as forest and land use. They are working on projects that cater to improving the livelihoods of people and communities and increasing access to water, health, food, infrastructure, built environment and ecosystem services.

Blended Finance

GCF is trying to operationalize the concept of blended finance and bridge the gap between public development capital and private capital. They aim to bring private capital in the blended transaction through concessional pricing and tenor. They also use smart subsidies to make sure that they are not distorting the market. They are also trying to use guarantees because guarantees provide support to financial institutions or other players, allowing them to deploy more capital.

Climate Technology

Some of the strategies employed include indulging senior equity holders to join and providing opportunities for junior equity working at an early stage in order to enable higher mobilization. They also work with incubators and accelerators in the technology space for climate technology. They recently invested in a technology transfer fund on adaptation, where they provided junior equity that somehow provides good subordination and enhancement of the transaction.

Looking Beyond Capital

GCF is trying to be catalytic in building financial resources but they also realize that in certain countries, they need things beyond capital. Therefore, in some cases, GCF provides technical assistance for capacity building capital, or grants to improve the enabling environment.

Instruments

 <p>Loans</p> <ul style="list-style-type: none"> • Concessional pricing & tenor • Relatively high-risk tolerance 	 <p>Equity</p> <ul style="list-style-type: none"> • Early stage risk • Enable higher mobilization 	 <p>Guarantees</p> <ul style="list-style-type: none"> • Tailored guarantees • Catalytic - enable crowding-in 	 <p>Grants</p> <ul style="list-style-type: none"> • Capacity building • Enabling affordability
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How we work

<p>Country-Driven</p> <ul style="list-style-type: none"> • Readiness programme supports country planning • GCF programming is aligned with country priorities 	<p>An Open, Partnership Organisation</p> <ul style="list-style-type: none"> • Over 200 Accredited Entities and delivery partners 	<p>A Range of Financing Instruments</p> <ul style="list-style-type: none"> • Leverage blended finance • Piloting support for new financial structures 	<p>Balanced Allocation</p> <ul style="list-style-type: none"> • Targeting 50:50 allocation between mitigation & adaptation 	<p>Risk-Taking, Patient Capital</p> <ul style="list-style-type: none"> • Accept higher risks to support early-stage project development & innovations to catalyse climate finance 
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4

Climate Risks and Financial System

Achieving carbon neutrality requires technological innovation and financial investment. But it also begs the question of the kind of risks associated with the transition. One such risk associated with the transition to a low-carbon economy would be the reduction in the demand and price for assets burning fossil fuels. Lower prices and demand could hit firms, investors, and workers relying on the assets and infrastructures. Unless financial institutions reduce their holdings of vulnerable assets in line with the pace of the transition, the risk may amplify into a systemic financial stability risk. This and other risks associated with transition call for an improved, country-specific understanding of how and to what extent the transition risk materializes and propagates to the financial sector, impacting financial stability as a whole.

The “Climate risks and the Financial System” section explores risk and uncertainty surrounding the financial impacts of a low-carbon transition and recent methodological advances in identifying and evaluating financial risks of a low-carbon transition at the sectoral and national levels. It also discusses how financial institutions can use various market instruments to overcome these risks and support innovative technology so that low-carbon technology can be developed and commercialized.



Assessing and Managing Risks Associated with Net Zero Transition



David Nelson
Senior Director
Climate and Resilience Hub at
Willis Towers Watson (WTW)

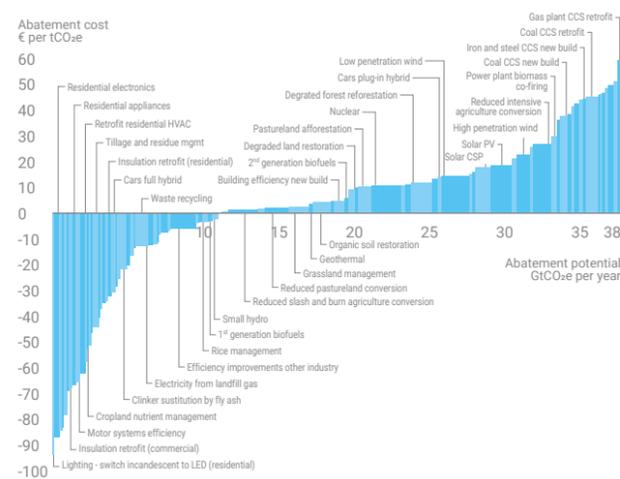
For years, there have been concerns over the trillions of dollars that might be invested in oil and gas, but the low-carbon transition is happening at a rate faster than what was expected by investors. As a consequence, the transition is leading to an increase in the number of stranded assets and challenges in the financial system. The question is how to move toward low-carbon development while minimizing the wastage of financial resources from investment in heavy carbon infrastructure that is no longer needed.

The graph on Sources of Climate Transition Risk depicts the different transitions needed and their associated cost. The GHG abatement cost curve clearly shows that only a third of the actions needed in 2008 create value for society. Social barriers such as farmers not knowing how to grow different crops or regulatory barriers prevent this value creation for society. There were also significant actions that were high on the cost curve that required research and development. It is clear from this graph that more than two third of the actions needed were responding to factors other than price signals.

Sources of climate transition risk

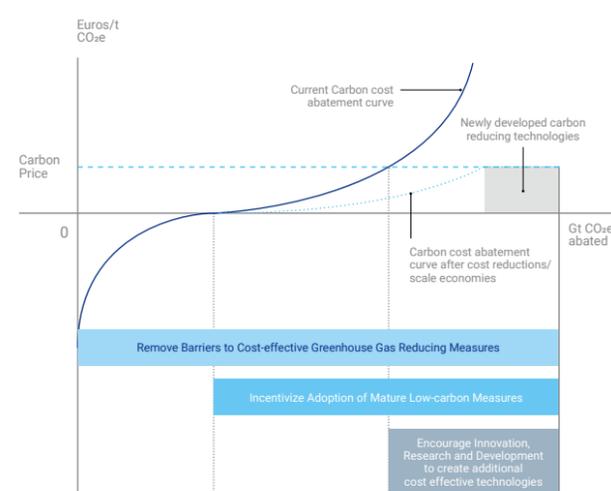
Many different types of transitions are needed, all of which have different solutions and risks

Global GHG abatement cost curve beyond business-as-usual - 2030



Note: The curve presents an estimate of the maximum potential of technical GHG abatement measures below €60 per tCO₂e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.
Source: Global GHG Abatement Cost Curve v2.0

Climate change policy objectives and the carbon abatement cost curve



And even those which could have been responding to price signals where carbon price could have had an impact, still had barriers or issues with the market structures that prevented them from happening. Some instances of risks associated with the climate transition have been detailed below.

Considering High Carbon Infrastructural Assets

The manner of winding down carbon intensive fossil fuels, transport and buildings must be factored in while discussing the transition. All of these, from an investors perspective, will lead to changes in the prices of these assets which will be reflected into the margins, production rates, and cost base. These changes will have a direct impact on asset values, investment opportunities in company portfolios and on sovereign risk. The difference between the valuation and market expectations of these assets because of the transition and the valuation of what they would have been worth is called the climate transition value at risk.

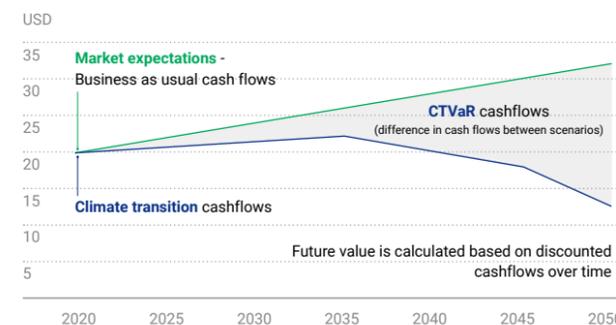
Aligning Demand with Financial Resources

Green transitions are often perceived as investing trillions of dollars and the market changing in an organized fashion around the low-carbon scenario, leading to the differences in prices. However, there are instances when the demand does not align with the finance. An illustration of this is when the supply for oil is limited to fewer fields. The development costs will increase for those fields and resultantly the price of oil will also be more volatile. These conditions will force companies to maintain low capital cost investments and alternatively have higher operating costs so they can bring on supply to meet the changes in oil demand.

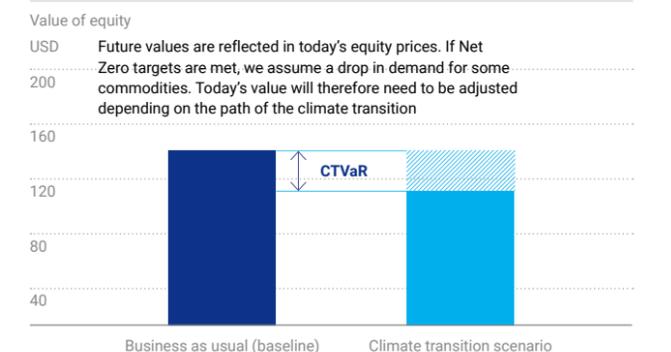
Climate transition value at risk (CTVaR)

The measurement of value lost due to a transition

Indicative predictive cashflows of a negative CTVaR company



Net present value



Climate Stress Testing and Financial Stability



Jeayoon Kim
Economist in the Financial Stability Department, Bank of Korea (BOK)

One of the major concerns of central bankers today is that the low-carbon transition can affect financial stability. Emission mitigation policies can increase the GHG emission costs of carbon intensive sectors. This could be detrimental to financial institutions holding assets of carbon intensive sectors. These risks are amplified in South Korea given its high dependence on carbon intensive sectors such as manufacturing sectors, steel and chemicals. However, low-carbon technology development, such as for renewable energy development, can alleviate the negative consequences of these potential risks.

The BOK has developed a climate-related stress test to analyze the impact of climate-related financial risks.

Methodology

The test is based on two underlying scenarios. The first is a 2 degrees Celsius scenario, which limits the temperature growth to below 2 degrees Celsius, and the second is a 1.5 degrees Celsius scenario, which limits the temperature close to below 1.5 degrees Celsius. The impact of carbon pricing policies and low-carbon technology development on corporate production cost, corporate value added and credit and market risks is then measured. Finally, a bank stability assessment is undertaken by analyzing the changes in the capital adequacy ratio of domestic banks. It is expected that banks holding financial assets with higher credit and market risk would suffer greater losses from transition risks.

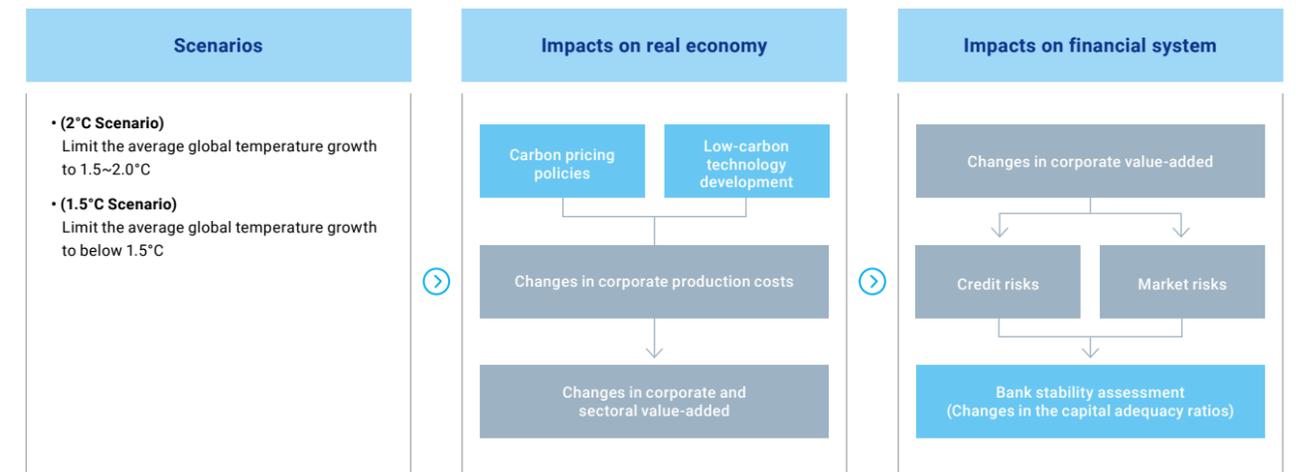
Risk Management

On the basis of the illustration above, one of the ways in which companies would manage risks associated with volatile prices would be by avoiding locking into high carbon solutions that are going to create the risk. Companies must endeavor to reduce the risk of existing investments through the contract structure, regulation or through risk engineering. Multiple transitions within the green transition would necessitate that companies adequately expose themselves in a way that balances the gas transition versus the electric vehicle transition versus the agricultural transition. Additionally, risk management tools such as hedging and insurance products, strategic evaluations and portfolio analysis should be invested in to reduce the risk.

Key Takeaways

- There are risks associated with the low-carbon transition which include stranded assets, volatile prices and value for society.
- Managing these risks would require:
 - Assessing existing infrastructure and how to minimize wastage
 - Aligning demand with financial resources
 - Using risk management tools such as insurance and portfolio analysis

BOK's climate stress test

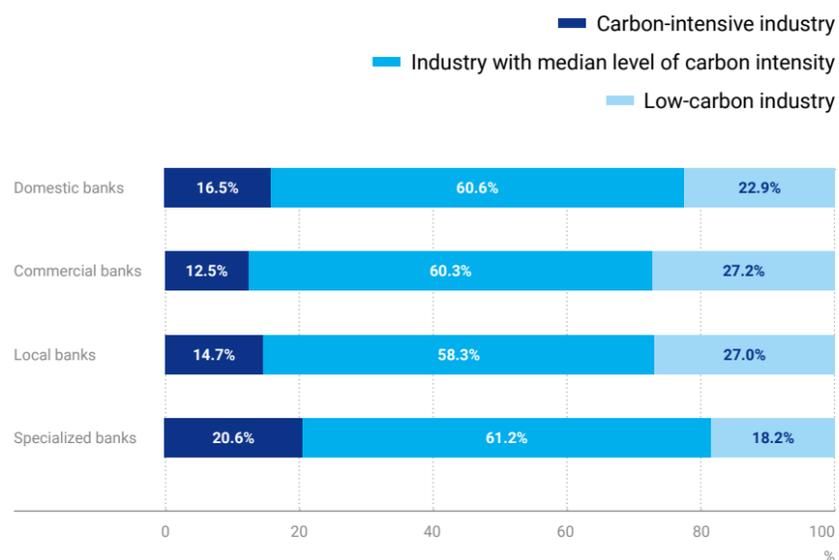


Results

- **Increased regulation to achieve carbon neutrality:** In the 2 degrees Celsius scenario the government reduces GHG emissions by about 70 percent by 2050 compared to those of 2020 and in the 1.5 degrees Celsius scenario the government achieves carbon neutrality by 2050. The latter scenario needs stricter regulation to limit emissions and so in the second scenario, the carbon prices are increasing more rapidly.
- **Transition risk increases the market and credit risk of carbon intensive sectors:** In both scenarios, the default rate rises rapidly and the stock price decreases significantly in carbon intensive sectors. However, the default rate and stock prices of less carbon intensive sectors are not changing as much. Therefore, the value of financial assets of carbon intensive sectors will decline significantly due to transition risks in comparison to less carbon intensive sectors.

Bank's holdings in carbon-intensive industries

Changes in the BIS capital ratios by bank types



Change in Capital Adequacy Ratio of Banks with Transition Risks

As the value of a bank's assets in carbon intensive sectors declines, the capital adequacy ratios fall by up to 2.6 point in the 2 degrees Celsius scenario and by up to 5.8 point in the 1.5 degrees Celsius scenario. Banks suffer losses more severely after 2040 in the 1.5 degrees Celsius scenario as emission prices rise rapidly from 2040.

Impact of Transition Based on Bank Type

The magnitude of losses from transition risks is greater for banks with larger holdings in carbon intensive industries. In particular, specialized banks that have heavily invested in the infrastructure industry, which has a large amount of carbon emissions, suffer great losses from transition risks in the 1.5 degrees Celsius scenario.

Impact of Transition Risks on the Korean Financial System

Given the current situation where emission reduction technologies to ensure carbon neutrality are not commercially available for manufacturing sectors, transition risks could impose considerable harm on the economy and the financial system. Unless banks respond properly to transition risks, financial assets vulnerable to transition risks will likely deteriorate and cause large losses at banks. This proves that banks need to establish a risk management system that incorporates climate change risks.

Key Takeaways

- Transition to low-carbon development could have a significant impact on the financial stability of banks.
- Financial risks associated with the transition vary based on the severity of regulation, the portfolio distribution of high carbon and low-carbon intensive industries, and the commercial viability of carbon reduction technologies.

Climate Risk Assessment Tools



Jaehak Hwang

Senior Manager, Sustainable Finance Team
Financial Supervisory Service (FSS), Republic of Korea

Scenario analysis in risk management uses the concept of Climate Value at Risk (CVaR), which was first suggested by Professor Simon Dietz of London School of Economics and Political Science (LSE) in 2013. It has been developed over the years, and is now being used commercially, especially by MSCI. CVAR is used as a part of the dynamic integrated climate-economy (DICE) model. Scenario analysis has become an important tool to examine transition and physical risks, but the results could be dramatically different depending on what scenarios were used for analysis. However, climate risks are influenced by numerous factors, such as temperature, soil ecosystem, forestry, financial system, industry, and more. So, it is difficult to figure out whether the effect is due to economic, financial, or biological influence. Therefore, in order to come up with a good scenario to examine the climate risks, financial experts and scientists need to collaborate. In fact, the European Central Bank (ECB) and BOE have started to hire climatologists to improve the scenario analysis research. The concept of CVAR has improved the risk management studies, but this is not widely known among the stakeholders. The financial industry has been using the concept of value at risk for decades, so the concept of CVAR should be easy to understand. It is suggested that the definition of CVAR should be brushed up and widely used for easier communication in discussing the financial aspects of climate risk.

As for climate stress tests, central banks and regulatory authorities usually use a top-down approach, where scenarios are developed to analyze the effect on the banks and examine the risks along the pathway. Different approaches need to be considered because of the uncertainties that climate change brings. A bottom-up approach is being used to measure risks, which involves low-level banks or companies measuring the risks by themselves. This approach is preferable since different businesses and different industries have different structures, which complicates the measurement. Physical risk is gaining spotlight given that natural disasters such as typhoons or storms account for 90 percent of damage caused in South Korea. So, performing stress tests for typhoons and storms would be beneficial in South Korea. HSBC thought there would be a lot of flood damage in India and based on their stress test results, they created mortgage loan packages to include housing insurances for that area. Similarly, other global financial institutions are also systematically working to reflect climate risks in their business strategies.

✓ Key Takeaways

- Scenario analysis is a useful tool to determine transition associated risks. However, reaching a precise analysis will require choosing an appropriate scenario and this can be achieved through collaboration with financial and climate experts.
- Climate stress tests involve a bottom-up approach to measure risk in relation to ESG measures. The aim of undertaking these tests is to be able to integrate such risks into the business strategies.

Key Considerations in Climate Stress Testing



Jacob Gyntelberg

Director of Economic and Risk Analysis Department
European Banking Authority (EBA)

The EBA has been performing stress tests in Europe which includes assessing the bank's robustness, risk management requirements for banks, and the prudential capital requirements for banks. The time horizon is the main challenge from a prudential regulatory perspective. Today, the prudential regulation has a somewhat shorter time horizon of 1 to 2 years or 5 years rather than the typical 30 years or the maximum duration of debt variant that we have inside the regulation. Therefore, we need to think about the forecastable climate risk and what it means for banks in the longer run. It is not an easy task due to lack of data, but it is on the agenda for the regulators.

The challenge today is to figure out what constitutes the new baseline. The task ahead is complicated but there is a strong political push in the EU to do something about this. The EBA has been asked to do more stress testing, to work with other agencies to cover insurance, to look at greenwashing issues, and to look at the prudential requirements. Also, new rules have come out in Europe that force greater disclosure by banks and companies. There is a broad set of policy measures and efforts being taken in terms of setting up a new set of rules for banks and the financial industry, which has an indirect impact on the clients of the banks. Therefore, the political environment has reacted, and the regulatory community is doing its part.

It is also important to keep in mind that banking regulation is there to ensure financial stability. It is not intended to steer resource allocation directly. So, the important caveat is that if there is a clear indication, the risks will go up and then this needs to be adequately reflected in capital requirements, prudential requirements, and risk management requirements for banks. But the challenge comes if you start using that system to do anything more than that such as steering resource allocation by twisting prices without good information. There are other ways and other policy tools you can use to direct resources, such as carbon taxes, subsidizing investment in housing, or other things that go straight to the source, instead of trying to do it indirectly through banks. It is the task of the banks to find a good balance between the challenges of what they're trying to do and what they've been asked to do by the politicians.

✓ Key Takeaways

- Regulations have a shorter time horizon of 1 to 5 years but financial institutions need to consider longer time horizons in forecasting climate risks.
- Regulators and supervisors are responding to the political push in the EU by using stress testing tools, working alongside other agencies and applying new policy measures and rules within the financial industry.

Integrate Climate and Environmental Science into Financial Decision Making



Ben Caldecott

Director, Oxford Sustainable Finance Group and the Lombard Odier Associate Professor of Sustainable Finance, University of Oxford

Director, UK Centre for Greening Finance and Investment (CGFI)

A few months prior to COP26 in Glasgow, the IEA published its Net Zero Emissions by 2050 Scenario (NZE). The IEA's NZE is the first IEA scenario that limits the increase in global average temperatures to 1.5 degrees Celsius, which is the aim of the Paris Agreement. In broad terms, the NZE discusses four subjects and the changes that will be required across them. These have been detailed below:

—— Fossil Fuels

Apart from projects already approved and in existence, new oil, gas and coal resources and reserves are simply not required. There are enough fossil fuels upstream to meet energy requirements.

—— Net Zero

The goal is to achieve net zero emissions in electricity in advanced economies by 2035 and by 2040. Globally, this means there should not be any new coal fired power stations, and generation from unabated coal needs to be phased out by 2030 and for advanced economies by 2040. Unabated natural gas generation needs to fall by 90 per cent by 2040, with any remaining capacity focused on grid flexibility and reserve.

—— Green Finance

Large investments are needed in renewable energy and storage to decarbonize energy systems. It is estimated that investment in electricity generation rose from about 500 billion USD per year last year to 1.6 trillion USD per year in 2030, of which renewables account for 1.3 trillion USD per year. The financial institutions serious about their net zero commitments need to end project finance in new fossil fuel reserves and in new coal fired power generation. Over 50 percent of the financing available for renewable energy, for example, comes from corporate balance sheets rather than project finance. Financial institutions have several policies to restrict financing for fossil fuel expansion. All 25 of the biggest banks in Europe are ending project finance for coal and placing more restrictions on corporate finance with companies engaged in high carbon intensive activities. Similar policies have yet to be developed and deployed widely for oil and gas reserves and for gas power, with the exception of some unconventional production, such as tar sands and Arctic drilling.

—— Energy Security

The most effective way of improving energy security over the medium to long term is to accelerate investment in low-carbon power and to reduce dependence on volatile and expensive fossil fuels. While the NZE was created first and foremost as a decarbonization scenario and a decarbonization pathway, the tools created for it, such as climate stress testing frameworks, can be used to assess energy security shocks and how to address them. One such energy security shock is the energy transition in light of the Russia-Ukraine war. It is asserted that the profile of the pathway will change, but the destination will stay the same. The reason for that is that reductions that were planned in fossil fuel consumption over the next 12 to 36 months are not going to happen in the way that was envisaged. People are going to be running existing fossil fuel assets more than they otherwise would have done to get away from Russian gas. But we're also going to see and already see very significant plans underway to boost deployment in renewables and energy efficiency. And so that essentially means that there will be this accelerated decline of fossil fuels in the late 2020s and 2030s above and beyond what was previously thought.

Even though net zero targets seem like distant ones, the measures that society will need to take to tackle climate change are very steep. Reductions are needed to enhance resilience and ensure that we can provide safe, secure and affordable energy to the different societies around the world. The starting point for the financial institutions and regulators is to think about energy security and on what needs to happen. Adjusting these off the shelf net zero pathways and analytics would be a good starting point for that analysis.

✓ Key Takeaways

- The IEA published a report on net zero scenario by 2050 which limits temperature increase to 1.5 degrees Celsius, consistent with the Paris Agreement.
- In order to achieve this IEA's net zero scenario, we need to refrain from investing in any new coal fired power plants or similar capital toward carbon intensive sources of energy and alternatively invest in renewable energy and storage to decarbonize energy systems.
- Tools such as climate stress frameworks can be used to predict energy security shocks and realign course accordingly.

5

Successful Practices and Strategies for Institutional Transformation in the Asia-Pacific

Climate change and associated policy responses, if not properly managed, present large economic, financial, and social risks around the world, and Asia may be more vulnerable than other regions. A significant portion of businesses, assets, and infrastructures that propelled Asian economic development and prosperity may become “stranded” and will become effectively worthless by 2050 as the world pursues weaning itself off fossil fuels. The question is how to plan for an orderly, efficient, and just transition to sustainable Asian economies.

In this section, representatives of international organizations and universities share their opinion on successful sustainable finance practices and strategies in the Asia-Pacific that have been implemented and challenges that must be overcome in order to move their broad-based institutional transformation forward and achieve a climate-resilient future for Asia.



Facilitating Global and Local Partnerships



Helena McLeod
Deputy Director-General and Head of the Green Growth Planning & Implementation (GGP&I) Division
Global Green Growth Institute (GGGI)

GGGI is an intergovernmental organization, committed to change in terms of the climate and biodiversity agenda. GGGI has many funders and partners of which South Korea is one, particularly with regard to the signing of the Korean Green New Deal for 25 million USD over the next 5 years. GGGI has about 42 members globally across Latin America, Africa, Asia, Europe and the Caribbean.

Saving the planet will require radical partnerships; radical innovation; and radical results. Particularly in terms of radical partnerships, the GGP&I is working with the KDB, for a 200 million USD initiative to incubate climate technologies in Asia. In terms of radical results, the GGP&I worked alongside 25 of their partner countries to provide technical assistance to aid in submitting their revised nationally determined contributions in 2020. The GGP&I is not limited to strategizing but helps to mobilize finance to implement these green strategies and transition plans.

Some of the GGP&I's key areas of work have been discussed below:

Thematic Bonds

The GGP&I helped mobilize about 5.2 billion USD worth of green bonds with their partners, which involved developing the framework, helping them identify the sectors that will be recipients of the bond and then helping them in terms of setting up the framework for monitoring. GGP&I is working on these in Latin America, Vietnam and Indonesia among other countries. But the opportunity for building the green bonds market in Asia is the greatest, given that presently only 5 percent of the investments are in the form of green bonds.

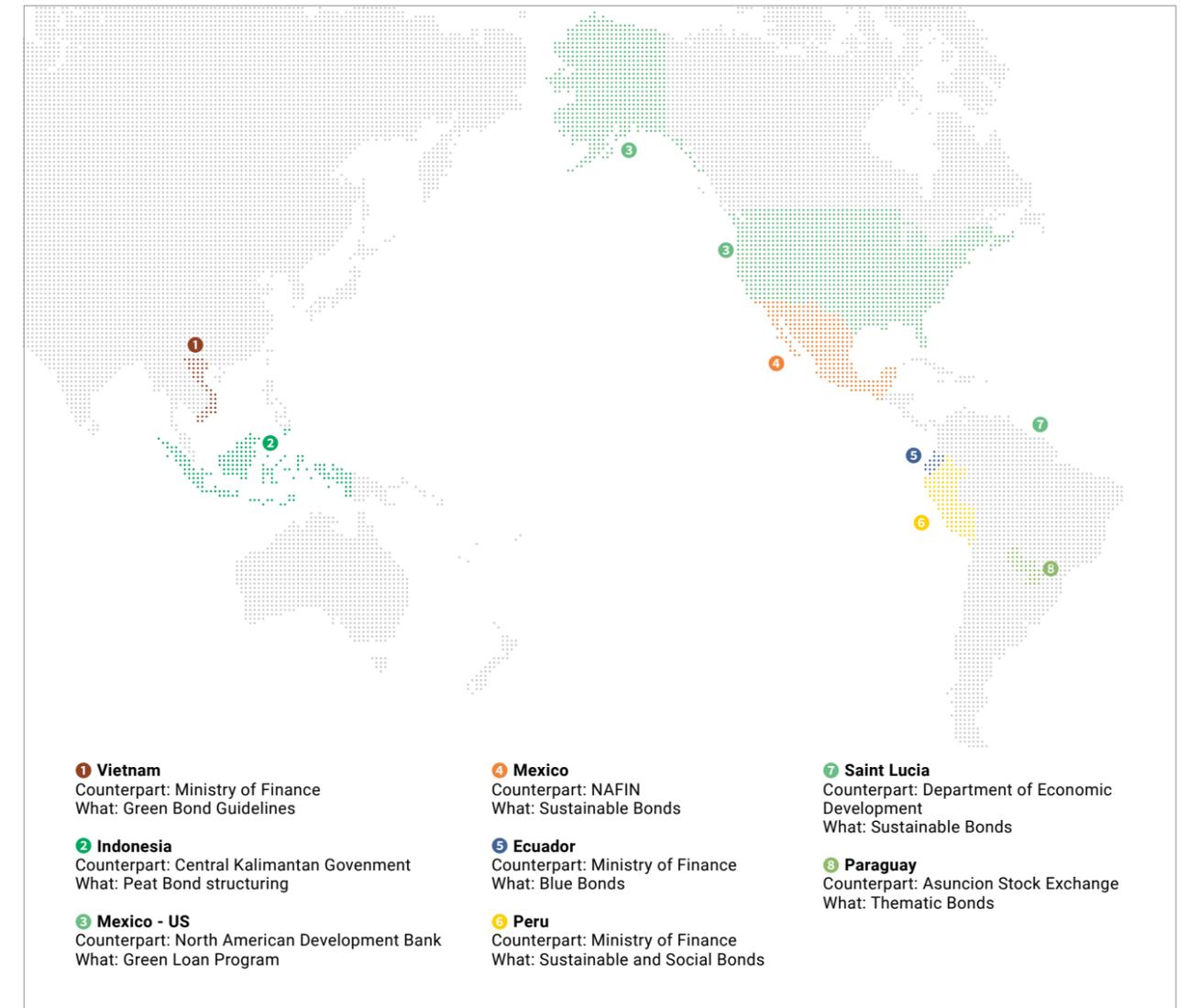
Carbon Markets

GGP&I is working with both countries that want to buy a carbon trade and those who want to sell a carbon trade. They work with countries on developing the framework, but position themselves as neutral partners with no special interest for either the buyers or the sellers. There is a potential market of about 1 trillion USD for these carbon trades.

Project Preparation

GGP&I helps partner countries in developing green mobility, circular economy, renewable energy and adaptation projects, with a focus on developing bankable projects. Their role is to help countries identify the right projects, mobilize funds and implement them, given that most countries often lack the resources to undertake these tasks.

GGGI's thematic bond portfolio 2022



Key Takeaways

- GGGI is an intergovernmental organization that works with member countries to encourage radical innovation, develop radical partnerships and create radical results in the climate and biodiversity space.
- GGP&I has made significant contributions by helping partner countries mobilize funds through thematic bonds, develop carbon markets and identify projects in the renewable energy, climate mitigation and adaptation space.

Mobilizing Private Sustainable Development Project Funding Through Blended Finance



Bruno Carrasco
Director General & Chief Compliance
Officer
Sustainable Development and
Climate Change Department
Asian Development Bank (ADB)

It is often said that the battle against climate change will be won or lost in Asia, given that Asia and the Pacific currently contribute to slightly over 50 percent of GHG emissions across the world. Recognizing this, the ADB is committed to becoming the climate finance bank for the Asia-Pacific region. The commitments can be broadly categorized across finance, technological and policy level commitments.

Financial

The ADB has raised its climate finance ambition from 80 to 100 billion USD from 2019 to 2030, of which 34 billion USD is toward adaptation and resilience. Additionally, the ADB is focused on better aligning their portfolio with international agreements, particularly the Paris Alignment. As part of this commitment, the ADB will have 100 percent of its sovereign portfolio aligned by July 2023, 85 percent of its non-sovereign portfolio by that date, and then the remaining 15 percent by July 2025. Additionally, the energy transition mechanism currently being developed and not employed by the ADB involves decommissioning some coal plants to be able to reduce the lifespan of the coal plants to reduce GHG emissions. This mechanism would accelerate the transition towards cleaner sources of energy. How can this be achieved? The ADB aims to receive this financial support by mobilizing blended finance and looking at ways to tap into the private sector and philanthropists. There is an increasing need to green the markets through green bonds, blue bonds and other innovative financing instruments. There are efforts to have more content contingency financing guarantees to be able to mobilize increasingly more and more resources. Finally, the ADB is also focused on applying carbon pricing and the Paris Agreement's Article 6 carbon markets.

Policy

Last year, the ADB ramped up support for climate initiatives by committing to a new energy policy where they basically support the transition toward cleaner energy. The ADB has chosen to categorically avoid reliance on coal and by supporting technological innovation in cleaner fuels such as green hydrogen. For natural gas, the ADB precludes exploration and drilling and currently supports natural gas under certain limiting conditions. The ADB is committed to the goals of 'just transition'. Additionally, the ADB is continually supporting countries to become much more ambitious in terms of the NDCs.

Technological

The ADB is currently focused on improving battery coverage and increasing utilization. But the ADB also recognizes that technology is needed to support additional financing and capacity development.

Key Takeaways

- The ADB is committed to becoming the climate finance bank in the Asia-Pacific region, given that this region contributes to a little over 50 percent of the global emissions and therefore, global climate success hinges on the success in this region.
- The ADB aims to support climate action in the Asia-Pacific region through innovative financial instruments, increasing own funds and mobilizing private sector funds for mitigation and adaptation efforts, helping nations transition away from coal and encouraging technological innovation.

Governance of Green Bond Markets



Suk Hyun

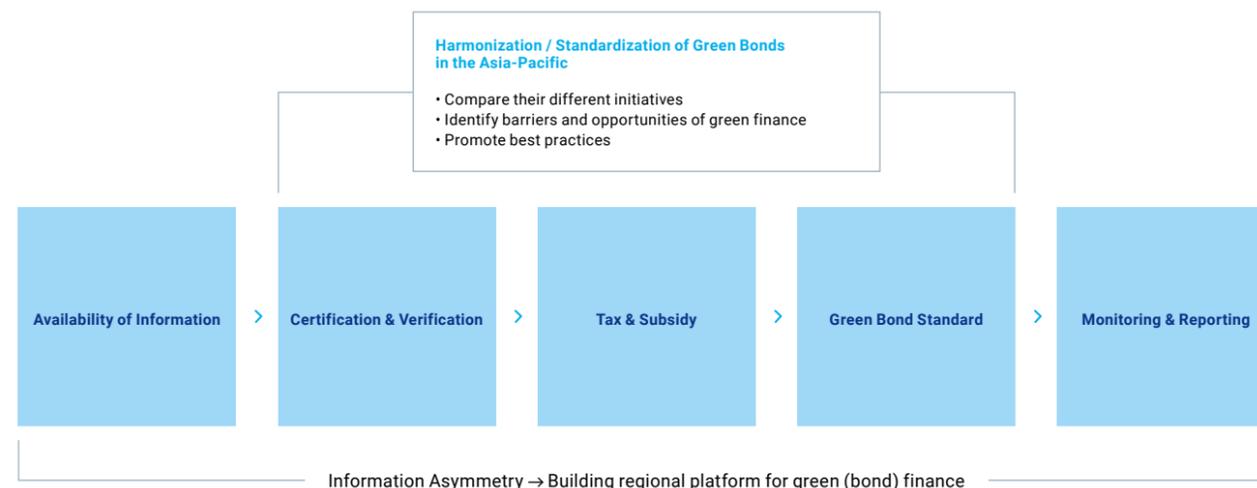
Associate Professor of Graduate School of Environmental Finance Yonsei University

There is an increasing number of green bonds being issued in the financial markets in the Asia-Pacific region. But the question is whether these projects have a positive environmental impact. Green bonds are very different from general bonds because the usage of the financing is very specific, and that is why there is increasing concern and interest in the utilization of the green bond.

A study finds that after issuing green bonds, recipients of green bonds often fail to disclose information on the allocation of the proceeds, where from 2017 to 2019, 77 percent of the green bonds disclosed information on the allocation of proceeds and 59 percent quantified the environmental impact of the financed project. Another study on the green bond market in China shows that some green bonds were used for non-green projects or greenwashing projects. Therefore, disclosure is critical for investors, especially when issuing green bonds.

The chart below shows the interest in green bonds and greenwashing identified by Google Trends. It shows that there is an increasing interest in green bonds but a parallel increased incidence of allegations of greenwashing. Disclosure of information is crucial in reducing these instances of greenwashing and in increasing transparency. There are several green bond standards - international, regional and national standards - which have their own green bond guidelines and their specific taxonomy. This makes cross-border investment and disclosure practices difficult.

Building ecosystem for green bond market



In order to resolve the asymmetric issues, green bond issuers have been categorized as frequent and infrequent. Some of the advantages of this categorization are:

- Frequent issuers have repeatedly tapped the green bond market to finance green investments, allowing them to recycle existing knowledge and market relationships in any subsequent green bond issuance, making the marginal cost of an additional green bond issuance less costly.
- Frequent bond issuers have conducted more reporting and monitoring of green bond proceeds, which provides more information on an issuer's reliability relative to new or infrequent bond issuers.
- By frequently issuing green bonds, issuers also signal a stronger environmental commitment by persistently investing in green projects and gaining the confidence of investors, thus lowering financing costs.

Therefore, infrequent green bond issuers pay 114-177 basis points more than their frequent bond issuer counterparts, which can be attributed to existing green bond pricing factors such as maturity, credit rating, liquidity and green label. The policy implications of these show that it is important to further develop the green bond market ecosystem and reduce information asymmetry via disclosure requirements. Information enhancing financial services, intermediaries, and policymakers should encourage existing green bond issuers to continue issuing green bonds. Additionally, there is a pressing need to create a regional symmetric system because countries differ in the standards for green bond issuance.

Key Takeaways

- With the increase in the number of green bonds, there is a corresponding increase in the alleged instances of greenwashing.
- A large concern of greenwashing is with regard to the lack of disclosure of allocation of the proceeds and the quantified impact of the finance project. This could be attributed to differing national, state and international standards for disclosure.
- Categorizing green bond issuers as frequent and infrequent helps to lower financing costs and increase reliability.

Research Agenda of the Asia Sustainability Forum

Research Activities and Conferences



Asia Sustainability Forum

Asia Sustainable
Finance Forum 2022

Stanford-Asia Sustainability Forum
Research Roundtable

Asia Sustainability Forum

The Asia Sustainability Forum convenes academic scholars, industry practitioners, and policymakers in Asia to discuss the integrated actions toward the global sustainability transition. The Forum focuses on advancing the understanding of the entire ecosystem that incorporates technology, business, finance, and policy related to sustainability and climate mitigation.

The Forum hosts a series of academic-industry collaborative conferences in Asia that facilitate in-depth discussions on how the transition movement toward sustainability of each sector or discipline is related to one another and develop long-term global research collaborations. The hosted conferences present new research and market practices on financial products and policies that support transitioning from fossil fuel and reducing GHG emissions in Asia. The discussions also cover ways to engage a broad range of stakeholders and to improve the governance of climate actions.



1



2

- 1 — SCIGC Opening Ceremony
- 2 — Stanford-Asia Sustainability Forum Research Roundtable
- 3 — Stanford Doerr School of Sustainability

3



Asia Sustainable Finance Forum 2022

March 24, 2022, Seoul, South Korea

The Asia Sustainable Finance Forum 2022 was the inaugural event organized by the Asia Sustainability Forum in partnership with Korea Advanced Institute of Science and Technology (KAIST). The event is hosted by the Financial Services Commission (FSC) of the Republic of Korea and sponsored by the Korea Development Bank (KDB) Group.

This open-to-public event clearly stated the Asia Sustainability Forum's vision by setting a new paradigm integrating technology, finance, and policy innovation in accelerating the net zero transition in Asia.

List of organizations that speakers are affiliated with:

Stanford University, KAIST, Seoul National University, University of Oxford, Yonsei University, Sungkyunkwan University, Korea Development Bank, Bank of Korea, Korea Chamber of Commerce and Industry, Korea Investment Corporation, Carbon Neutrality and Green Growth Commission (South Korea), Financial Services Commission (South Korea), Financial Supervisory Service (South Korea), National Policy Committee (South Korea), Bank of England, European Banking Authority, World Bank, United Nations, Asian Development Bank, ANZ, G20 Sustainable Finance Study Group, Green Climate Fund, Global Green Growth Institute, UK Centre for Greening Finance and Investment, Hanwha Energy Corporation, C-Zero, BloombergNEF, Willis Towers Watson



1



2



3

- 1 — Asia Sustainable Finance Forum 2022
- 2 — Asia Sustainable Finance Forum 2022
- 3 — Yeon-chul Yoo (Former Climate Change of MOFA, Republic of Korea)



1

2



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4



- 1 — (From left) Soh Young In (Stanford), Ali Izadi (BloombergNEF)
- 2 — (On screen) Ashby Monk (Stanford), (from left) Soh Young In (Stanford), Hoon Lee (KIC), Henry Gonzalez (GCF), Wook-sang Ahn (KDB)
- 3 — (From left) Yeon-chul Yoo (Former Climate Change of MOFA, Republic of Korea), In-Sub Jung (Hanwha Energy Corporation), Nok Young Kim (KCCI)
- 4 — Man-Sung Yim (KAIST)

Stanford-Asia Sustainability Forum Research Roundtable

June 17, 2022, Seoul, South Korea

The Stanford-Asia Sustainability Forum Research Roundtable convened experts from global and domestic institutions, including industry practitioners, representatives from investment institutions, academic scholars, and policymakers.

The Roundtable was organized as invitation-only in order to steer in-depth discussion among key stakeholders in Asia and to develop long-term global research collaborations. The discussions from this event successfully laid out the current landscape of the net zero transition in Asia and facilitated highly interactive discussions on outstanding challenges and ways to collaborate to address them.

List of organizations that speakers are affiliated with:

Stanford University, Korea University, Pusan National University, Korea Development Bank, Department of Energy (U.S.), U.S. Embassy Seoul, GS Caltex, GS Energy, Hyundai Motor, LG Energy Solution, SK Hynix, BloombergNEF, Kim & Chang



1



2

1 — (On screen) Steven Chu (Stanford)
2 — (From left) Jimmy Chen (Stanford), Kyu Ho Song, (GS Energy)



1



2

- 1 — Thomas Heller (Stanford)
- 2 — Marc Roston (Stanford)
- 3 — (On screen) Charles Kolstad (Stanford), (from left) Liang Min (Stanford), Joon Hyun Lee (Pusan National University), Kerry Cheung (DOE/U.S. Embassy Seoul, South Korea), Cheol Hong Huh (GS Caltex)

3



1

- 1 — (From left) Liang Min (Stanford), Jimmy Chen (Stanford), Yi Cui (Stanford)
- 2 — Breakout discussion for Sustainable Finance
- 3 — Breakout discussion for Storage and Transportation

2



3



Research Agenda of the Asia Sustainability Forum

Topics for Future Research Collaboration



System Integration and Transition

Sustainable Finance and Policy

Technologies for Sustainable Transition

System Integration and Transition

1 — Real World Challenges



Decarbonization of the power system

The current power system should be transformed to facilitate the integration of renewable and distributed energy resources. This transformation is required to manage the rising energy demand while reducing the fossil fueled power supply.



Lithium-ion

Low energy density of Li-ion batteries makes it suitable for light vehicles. However, if the technology is improved to increase the energy density, it has the potential to be applied to grid-level energy storage systems.

- **Safety issue:** A major problem is that there have been many accidents where Li-ion batteries kept burning. Research collaboration is needed to develop new chemistry to improve the safety issues.



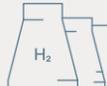
Grid management

Battery management system (BMS) is a powerful and smarter way of managing the status of the battery, but more research is required for this technology to become commercially available.



Scaling battery production

The main issue in the next couple of decades will be scaling up the battery production. Currently, batteries are largely used in the transportation sector, but better battery technologies would be needed to support the grid.



Fuel cell

High energy density of fuel cells makes it suitable for large cargoes by covering long distances and reducing the amount of time needed to recharge. Once it is up to scale, it has the potential to transform the current power system as it would be cheaper to transport energy by a hydrogen pipeline than through electric cables.

- **High cost:** Currently, the high cost is a major barrier. For example, the cost of zero emission fuel cell buses is extremely high at the moment.
- **Low efficiency:** Improvements of efficiency for hydrogen is important as hydrogen has only 36% efficiency while Li-ion batteries have 90% efficiency.

2 — Proposed Solutions



Coordinating supply and demand

Reducing the GHG emissions in the power system could be managed from either the supply or demand side. However, there are still a lot of challenges to better coordinate the supply and demand. The following suggestions could provide insight to overcoming the challenges.



Energy storage

The intermittency issues of renewable energy should be solved by improving the energy storage capacity to be cheaper and more reliable.



Regional grid

Expanding or establishing the interconnection beyond the local regional level to balance out the supply and demand issues.



Policy support

Developing policies to facilitate decarbonization of the supply side, such as providing incentives to phase out fossil fuels and investment strategies to address adverse effects from phasing out of fossil fuels.



Decarbonizing supply side

The available carbon-free supply options should be expanded, such as increasing the use of nuclear energy. However, the social acceptance bar is high, so nuclear technologies should be improved to be reliable, failsafe, modular, and low waste generators.



Hydrogen-based economy

Hydrogen will play a vital role in accelerating carbon neutrality by providing clean fuel and surplus power storage.



Building an enabling environment for clean energy

Current power system is a centralized and one-way system, but it should be transformed into a decentralized, participatory, and multi-way grid system.

Sustainable Finance and Policy

1 — Real World Challenges



Need for new policies and financial systems

The current policy and finance systems are adapted to the kinds of technologies that were the dominant forms of production in the past. Unless these systems are changed, there will be a long delay in realizing the benefits from the new technological innovations, which would lead to economic costs and slow the transition.



Evolving climate actions

The international community moved on to other forms of climate action, which marked a clear sign of shift in the focus of governance and climate action from the public sector to the private sector. The two climate actions are: green finance; and managing the climate risks (physical and transition risks).



Greenwashing

Companies are providing ESG data and financial institutions are selling indexes related to ESG products. As a result, abundant reports are being published but the studies have shown that there is no correlation between all these different standards. Therefore, the current system is subject to greenwashing and the carbon neutrality does not have legitimacy at its current state.



Transition in developing countries

Asia has experienced a massive transition in the past 30 years. Since this transition was mostly financed by the state, it cannot be written off without causing financial instability. As a way of filling this gap, the developed countries proposed to transfer financial resources to the developing countries to pay for the cost of transition, but this never occurred.



Accounting conventions to measure the risks

There's a great deal of momentum for carbon reporting, but there are some very fundamental problems with the way reporting is done. There has never been a proper accounting method for carbon stocks, so the actual carbon stock level in various sinks in different countries has never been properly calculated. Hence, there is still a long way to go for the accounting conventions to be agreed upon and practices to be credited as credible.

2 — Proposed Solutions



Improving the carbon accounting system

The carbon accounting system is still at a very early stage and the measurement of financed emissions has just started being developed with the help of the experts. Also, there are separate and independent procedures to screen green projects to ensure that these projects are aligned with the green taxonomy and help prevent any forms of greenwashing. For example, KDB is running a carbon finance program to offer favorable terms for mitigation projects. The impacts of the projects are strictly verified by a third party in both an ex-ante and ex-post manners. Therefore, measures are being taken to improve the credibility of the projects and the procedures will be further developed in the future.



Localizing the environmental regulations

The role of the government and policies are crucial for the reporting system to be implemented correctly. In Asia, the governments tend to impose strong regulation policies but sometimes these are copies of the European regulations without understanding the unique local situations, such as K-taxonomy. This has led to a lot of companies being puzzled by the new system as they are uncertain of the requirements. Hence, the governments should first understand the importance of these issues, then incorporate them into the local regulations in market friendly manners. By doing so, the business sectors would become more comfortable in integrating into the global reporting standards.



Establishing a new GHG protocol

The GHG protocol was developed more than 20 years ago under the assumption that global carbon pricing would be implemented, but it was never put in place. Scope 1 and 2 is important as it measures the direct and indirect impact of the business operations but attempts to measure Scope 3 are wasted dollars. Hence, the resources should be aimed at getting accurate measures of Scope 1 and 2 by increasing the frequency of the measurement. By doing so, real constraints on carbon emissions can be imposed and allow reallocation of capital to transform the energy systems.

Technologies for Sustainable Transition

1 — Real World Challenges



Innovative solutions for scaling-up

Technological innovation to scale-up the current technologies will be critical in enabling the sustainable transition. Renewable power generation has been scaling aggressively over the past decade, but unfortunately, sustainable options for transporting and storing energy at scale for both stationary and mobile applications remain elusive.



Low profitability of innovation

An innovative material and design could be researched, but the expensive pricing of these technologies would prevent it from being adopted. As ESG and other environmental issues are gaining more attention, the process is slowly changing but this is still an obstacle as it involves the whole value chain and every partner should be willing to participate in the innovation.



Disconnection between priorities

Innovation is slowed down when there is a disconnection between the priorities at the research level, development level and commercial level. It is crucial to bridge the gap between the different levels by understanding the different requirements, such as how the commercial requirements would impact and drive the R&D at the earliest stage.



Low business interest

The hundreds of terawatts of storage are required to establish a sustainable renewable energy system, but companies are still largely focusing on small scale batteries for mobility purposes. A shift in attention to large scale storage is required and academia has the potential to make the necessary input. The vast pool of talent in universities around the world could work to develop a scalable solution, which then can be built by the industry.

2 — Proposed Solutions



Co-location

One important aspect of innovation would be co-location. For example, Silicon Valley is a place with perfect co-location of all the key players and resources. It has an almost unlimited talent pool, especially with Stanford University in the vicinity, and the young students are eager to start a new business. Also, there are a lot of experienced entrepreneurs ready to collaborate with the university.



Business competition

In the case of fuel cells, companies see great business opportunities in this field, so they are investing heavily into innovating the technology. For example, Hyundai Motor Corporation is also investing into the development of fuel cells for mobility, such as passenger cars and commercial vehicles. As there are a lot of competitors in this field, the companies focus on reducing the price to a reasonable level that can satisfy the customers.



Market availability

Innovation opportunities would rise from the market availability. There are plenty of potential countries or regions that are not blessed with abundance of natural resources. These countries are showing much interest in investing into technological innovations. In the case of South Korea, there are not many opportunities to use renewable energy, but on the other hand, this creates an ample opportunity to make use of SMRs and pink hydrogen.



Collaboration opportunities at different levels

Collaborative effort is a key for successful innovation and there are various collaboration opportunities at different levels.

- **Collaboration at the national level:** Once the governments share a common view on the clean energy transition, the ministries could take up the role to fund and promote collaborative projects between countries.
- **Collaboration at the private sector level:** Companies have abundant experience in the field and are aware of the technologies required by the market. Industry-academia collaboration is a common method of developing new technologies.
- **Collaboration at the university level:** Collaboration between universities tend to be more flexible than other levels. One method to encourage the collaborative effort would be to establish a platform for research teams to easily contact and conduct joint research.

Sustainable Finance in Asia

Next Steps for Climate Innovation