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Building the Banking Sector's Capacity for Green Infrastructure Investments for a Low-Carbon Economy

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Abstract: The construction of green infrastructure, using advanced technology and retiring inefficient technology, is essential for the low-carbon transition. Various green infrastructure programs are being implemented, and banks play an important role in facilitating these programs. Many lessons have been learned in improving finance for green infrastructure: (i) measurement, reporting, and verification is a useful tool for identifying green infrastructure investment; but just reduction is not enough for Green Infrastructure and three requirements – carbon dioxide emission reductions, improving energy access, and contributions to sustainable economic growth – connected with the Sustainable Development Goals are necessary; (ii) banks can contribute to realising a positive cycle of cost reduction and diffusion of advanced technology for reducing costs by scaling up markets; and (iii) carbon pricing is essential for removing carbon externalities and making green infrastructure commercially viable. Banks are recommended to have long-term strategies, improve their capacity for scenario analysis, have more dialogue with industry, and develop innovative finance such as carbon markets. Governments are recommended to adopt carbon pricing to encourage finance for green infrastructure.

***Keywords*:** Green infrastructure, SDGs, MRV, long-term strategy
***JEL Classification*:** Q54, G21, H24

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1. Introduction

The Paris Agreement confirmed the need for a low-carbon transition, and all parties to the agreement are taking actions to achieve their commitments. However, the target of limiting the global temperature increase to well below 2°C is very challenging and requires a huge amount of investment, e.g. $68 trillion additional investment by 2040 for the energy sector (International Energy Agency (IEA), 2018). Finance and technology transfer are crucial for supporting low-carbon investment. However, developing countries often cite a shortage of finance and lack of technology transfer at intergovernmental negotiations.

On the other hand, the financial sector is concerned about the oversupply of financial resources compared with demand – a 'money glut' – and institutional investors are seeking new markets for their finance. The financial sector expects climate-related finance to become a promising new market. Banks are diversifying from the conventional lending business model to a mixture of financial products, including bonds. Green bonds have been successful to date, but do not satisfy the aspirational demands of institutional investors and customers because the size of the green bond market is limited and they cannot expect large-scale profit from green bond derivatives. Lack of financial flows from the capital markets to climate change and a money glut are also observed.

This paper aims to resolve this mismatch and connect demand and supply through green infrastructure. It begins by introducing good practices before moving to lessons for banks and concludes with recommendations.

2. Green Infrastructure for Low-Carbon Transition

2.1 Taxonomy of Green Infrastructure

Various types of infrastructure can be considered 'green', and the broad definition varies widely. This paper focuses on energy-related infrastructure, which plays an important role in the transition to a low-carbon economy. It categorises green infrastructure as follows:

(i) **Low-carbon energy supply (supply side).** Various options are available for low-carbon energy: renewables, hydrogen (zero or low-emission hydrogen), and low-carbon fuel through carbon capture and storage (CCS). Nuclear power is understood as zero emission energy but excluded from the analysis in this paper.

(ii) **Energy efficiency (demand side)**

(a) Improving the efficiency of infrastructure, e.g. power generation, electric power network, and aviation and marine transportation.

(b) Low-emissions infrastructure, such as mass transit, which has less per capita emissions than personal mobility.

(iii) **Supporting infrastructure for low-carbon energy**. Switching to low-carbon emission factor energy – such as from coal to natural gas or from fossil fuels to renewable electricity – is often observed and tends to be used in industry, but this has many issues, including effective and continuous supply chains.[1] Supporting infrastructure needs to be constructed for the low-carbon transition, e.g. a liquefied natural gas supply chain for marine transport, an electric vehicle charging network, a hydrogen supply chain, and a carbon dioxide (CO_2) pipeline for CCS and/or carbon capture, utilisation, and storage (CCUS).

(iv) **Digital technology.** Digital technology will contribute to improving the efficiency of the supply chain. Digital infrastructure is also categorised as green infrastructure.

2.2 Requirements for Green Infrastructure

Green infrastructure does not have an official definition or de facto standard. A clear and transparent definition is needed for the effective use of finance or other resources and to avoid reputational risk, e.g. criticism such as ‘green washing’ or ‘fake bonds’.

[1] In many countries, the emission factor for electricity becomes lower because of the diffusion of renewable power generation.

Reducing CO_2 emissions is essential, but not enough. For instance, the IEA indicates three components – climate change, energy access, and improvement of air pollution – for its Sustainable Development Scenario (IEA, 2018). These three components are connected to the Sustainable Development Goals (SDGs):

(i) CO_2 emissions reduction – Climate action (SDG 13)

(ii) Energy access - Affordable and clean energy (SDG 7)

(iii) Sustainable economic growth – Decent work and economic growth (SDG 8) and Industry, innovation, and infrastructure (SDG 9)

3. Case Study – Japan

3.1 Public Finance

3.1.1 Overview of JBIC Approach

Policy-based public banks have a special political mandate and their priorities are modified according to the government's economic and foreign policies. They support individual projects through financing (direct contribution) and play a catalytic role in mobilising private funds through co-financing and messages to the market via their lending policy (indirect contribution).

Japan Bank for International Cooperation (JBIC), funded by the Government of Japan, has the mission to contribute to the sustainable development of Japan and the global economy and is an example of a public bank which finances green infrastructure. Table 1 summarises JBIC's approach to green infrastructure.

Table 1: JBIC's Approach to Green Infrastructure

Program/Policy	Purpose	Tools
GREEN	Finance program supporting greenhouse gas emission reduction projects, including infrastructure	J-MRV Guidelines for the confirmation of CO_2 emissions reduction
Quality Infrastructure/ QI-ESG	Finance program supporting higher quality infrastructure. CO_2 emissions reduction projects are eligible.	List of eligible technology and projects
Eligibility criteria for financing coal power generation	Limitation of finance support (best available technology is required)	Matrix of conditions: (i) CO_2 emissions intensity and technological, (ii) capacity of units, and (iii) economic development stage of host country
Environmental guidelines	Due diligence guidelines for reducing the risk of negative environmental impact by the financed projects	Screening sheet, check list by sector following JBIC's Environmental Guidelines

CO_2 = carbon dioxide; GREEN = Global action for Reconciling Economic growth and Environmental preservation; JBIC = Japan Bank for International Cooperation; J-MRV Guidelines = Guidelines for Measurement, Reporting and Verification of greenhouse gas (GHG) Emission Reductions in JBIC's GREEN; QI-ESG = Global Facility to Promote Quality Infrastructure Investment for Environmental Preservation and Sustainable Growth.
Sources: JBIC (2015, 2018a, 2018b).

3.1.2 GREEN

Global action for Reconciling Economic growth and Environmental preservation (GREEN) has been implemented since April 2010 to support greenhouse gas (GHG) emissions reduction projects. An essential condition of GREEN is the confirmation of projects' GHG emissions reductions. JBIC developed the Guidelines for Measurement, Reporting and Verification of GHG Emission Reductions in JBIC's GREEN (the J-MRV Guidelines (JBIC, 2018a)) to quantify projects' emissions reductions objectively (Table 2). Various measurement, reporting, and verification (MRV) methods were available, e.g. MRV for the Clean Development Mechanism (CDM), but JBIC decided to develop a more practical approach based on business customs and adopted 'simple and practical' as its principle.

Energy consumption is a critical cost for the economics of energy-intensive equipment, so it is inspected carefully during the commissioning of a project. CO_2 emissions can generally be quantified more easily if MRV follow business practices. The methodology for the J-MRV Guidelines is disclosed publicly, and borrowers and investors can estimate the reduction effect before applying for JBIC finance (Table 2). This is an example of the MRV approach for defining green infrastructure.

Table 2: JBIC's J-MRV

Project	Methodology
Renewable	Replacement of current power/heat supply by renewable energy sources
Energy efficiency (industry)	Replacement by more efficient equipment
Waste energy	Waste energy recovery for power generation
Fossil fuel power	Low-emission power generation by improving efficiency
Mass transit	Urban modal shift
Waste management	Methane capture from landfills
Water	Efficient water management, including the reduction of distribution loss
Co-generation	Improvement of energy efficiency by combining heat and power
Energy efficiency and renewable energy equipment	Expected reduction due to improved energy efficiency and the increased uptake of renewables
Energy management system	Optimisation of energy used through monitoring and analysis

- ✓ Methodology for evaluation and confirmation of GHG emissions reduction in JBIC financing (JBIC, 2018a)
- ✓ Principle: simple and practical, referring to internationally accepted good practices
- ✓ Basic approach
  a. Reduction is defined as the gap in emissions before and after investment. If an international de facto standard or regulation is available, it should be the baseline emission (benchmark).
  b. Estimation and model approach is accepted.

GHG = greenhouse gas; GREEN = Global action for Reconciling Economic growth and Environmental preservation; JBIC = Japan Bank for International Cooperation; J-MRV Guidelines = Guidelines for Measurement, Reporting and Verification of greenhouse gas (GHG) Emission Reductions in JBIC's GREEN.
Source: Hongo (2018).

3.1.3 Quality Infrastructure

Prime Minister Shinzo Abe announced the Partnership for Quality Infrastructure in May 2015, and JBIC has supported the projects under the partnership (Table 3). The list of technology and projects types is disclosed to the public, and investors have easy access to information on projects eligible for JBIC financing under the partnership.

Table 3: Potential Quality Infrastructure Projects for ASEAN

Category	Type	Projects
Energy	Natural gas	LNG supply chain
		Gas pipeline (domestic)
	Hydrogen	CO_2-free hydrogen production (by renewable and fossil fuels with CCS)
		Hydrogen supply chain
Electricity	Power generation	Low-carbon fossil fuel (gas) or renewables
		Fossil fuel with CCS
	Transmission	Capacity increase and extension, including cross-border link
		Electricity loss improvement, including transformer
	Network system	Energy storage, including pumped-storage hydroelectricity
		Demand response and system optimisation
		Inclusion of EVs in the system
CCS	CO_2 transportation	CO_2 pipeline network
		CO_2 tanker
	Containment and monitoring	Injection, storage, and monitoring by the public
		Long-term liability undertaking by the public (soft infrastructure)
Transport	Electrification	High-voltage charging system for EVs
	Gasification	Gas supply network (CNG, LNG)
	Railway and mass transit	High-speed city link
		Urban transport, including EV bus system
	Low-carbon transport fuel	Fuel switch to gas or hydrogen
	Fuel switch (clean fuel)	LNG supply chain
Others	Waste management	Waste to energy (incineration with power generation)
		Waste for material recycling
Digitalisation	Data platform	Optimisation supply chain system
		Sensor technology for monitoring
		Data platform

ASEAN = Association of Southeast Asian Nations, CCS = carbon capture and storage, CNG = compressed natural gas, CO_2 = carbon dioxide, EV = electric vehicle, LNG = liquefied natural gas.
Source: Hongo (2018).

JBIC has implemented this program through the Global Facility to Promote Quality Infrastructure Investment for Environmental Preservation and Sustainable Growth (QI-ESG) since June 2018. This facility will support a wider range of projects than GREEN, and its MRV process is simpler than that of GREEN when its GHG emissions reduction

is obvious. This program takes a narrative approach to providing messages to investors and borrowers.

3.1.4 Conditions of Finance for Coal Power

Coal power generation is controversial because the CO_2 emission factor of unabated coal power is higher than that of advanced coal and gas power generation, and should be reduced to help combat climate change. However, some countries and regions need coal power generation to respond to the rapid increase in electricity demand. The balance of CO_2 emission reductions (SDG 13), energy access (SDG 7), and economic development (SDGs 8 and 9) should be considered. Member countries of the Organisation for Economic Co-operation and Development (OECD) agreed on guidance for finance for coal-fired power plants in October 2015. This agreement is summarised in a matrix by the technology or emissions factor, capacity of equipment, and economic development stage of the project location country (Table 4; OECD, 2015). The availability of alternative sources of energy, taking into account both economic and local resource constraints, was crucial for the intergovernmental policy debate although it is not explicitly stated in the OECD guidance on coal power plants. Multilateral development banks have adopted a similar approach. There are various types of eligibility criteria for funding of coal power plants, but these criteria are not recognised as an investment signal for the low-carbon energy transition.

JBIC and all public finance agencies in OECD member countries should follow a benchmark approach when they consider financing coal-fired power plants.[2] In the case of export-import banks such as JBIC, such guidelines serve not to regulate private banking finance but to influence the decisions of private banks towards a low-carbon transition. JBIC co-finances infrastructure projects with a network of private banks and Nippon Export and Investment Insurance (a public export insurance agency) covers the risk of lending by private banks. The OECD (2015) guidelines seem to be a de facto international standard. However, public banks in non-OECD member countries, including China, are not subject to them.

[2] OECD member countries provide official export credits through export credit agencies in support of national exporters competing for overseas sales, and they have finance rules called ‘arrangements’ (OECD, 2019).

Table 4: OECD Guidance on Finance for Coal-Fired Power

Plant unit size (gross installed capacity)	Unit > 500 MW	Unit ≥ 300 to 500 MW	Unit < 300 MW
Ultra-supercritical or emissions < 750 g CO_2/kWh	12 years	12 years	12 years
Supercritical or emissions between 750 and 850 g CO_2/kWh	Ineligible	10 years, and only in IDA-eligible countries	10 years, and only in IDA-eligible countries
Subcritical or emissions > 850 g CO_2/kWh	Ineligible	Ineligible	10 years, and only in IDA-eligible countries

CO_2 = carbon dioxide, g = gram, IDA = International Development Association, kWh = kilowatt-hour, MW = megawatt, OECD = Organisation for Economic Co-operation and Development.
Source: OECD (2015).

3.1.5 Sustainability and Safeguards

JBIC does not have specific sustainable development guidelines or criteria. It reviews the nature of a project based on its mission – to contribute to sustainable development.

JBIC also reviews other aspects of green infrastructure to avoid negative environmental impacts. This is sometimes called the confirmation of 'no net harm'. It uses its Environmental Guidelines to confirm the avoidance of unacceptable negative environment impacts (JBIC, 2015). These provide principles, procedures, and a check list for environmental due diligence, including pollution control, the environment, and social issues, as well as monitoring mechanisms. An important approach of these guidelines is to ask 'why' if there is a gap between a project's environmental considerations and Japanese or international regulations, practices, or standards. JBIC does not apply Japanese standards automatically to a project. The first step of its review process is a gap analysis, followed by a review of why the gap is present.

JBIC has a principle of co-financing with private banks. Japanese private banks have improved their environmental due diligence capacity by participating in JBIC's environmental due diligence through co-financing.

3.2 Government Subsidies Program

3.2.1 Price Effect and Revenue Boost Effect

Green infrastructure is needed for the low-carbon transition, but carbon externalities are a critical barrier. Regulation of CO_2 emissions and/or incentives are used to remove the externalities.

Many countries have adopted carbon pricing, including carbon taxes and emissions trading. Each instrument is different, but they all have strengths and weaknesses. For instance, carbon taxes should be high if they are to reduce the emissions alone, since the price effect is rather small – particularly in the short term. However, incentives directly improve the economics of projects and influence investment decision making. Japan adopted a global warming prevention tax in 2012. Following the economic analysis on the impact of the emission reduction tax, the price effect was 0.2%, although the revenue boost effect was 0.4%–2.1% (Hongo, 2018). Now, about ¥30 billion a year is collected and this should be used effectively for reducing emissions.

3.2.2 Modalities of Subsidy Program Using MRV

Quantification of the reduction cost is considered as an approach for improving the efficiency of subsidies, and various applications are used (Table 5).

Table 5: MRV for Improving the Efficiency of Subsidies

Application of MRV	Outline
Ex-post review of subsidies program (in place)	Reduction amount supported by subsidy is quantified Policy cost is obtained from the following equation: cost (¥/tCO_2) = subsidies amount (¥) / reduction amount (tCO_2) Evaluation outcome is used for improving the subsidies program
Requirement for subsidies (in place)	Subsidies are provided after the confirmation of emission reductions through MRV. In some MOE programs, banks provide finance to the projects, reviews reduction through MRV, and receive incentives from MOE. Amount of incentives is determined by a fixed rate.
Outcome-/performance-based incentives	Subsidy amount is determined by the amount of reductions confirmed by MRV: reduction amount (tCO_2) × pre-determined price (¥ or $ /tCO_2) This mechanism has not been implemented in Japan, but it was proposed to the UNFCCC.*
Purchase of reduction (in place in Australia)	Government purchases the reduction amount confirmed by MRV through auction. This looks like emissions trading, but the buyer of the reduction is the government and the price is quite stable, e.g. Australia's Emissions Reduction Fund.**

MOE = Ministry of the Environment; MRV = measurement, reporting, and verification; tCO_2 = ton of carbon dioxide equivalent; UNFCCC = United Nations Framework Convention on Climate Change.
* This was proposed to the UNFCCC (Hongo, 2013).
** Government of Australia (2019).
Source: Author.

Japan's Ministry of the Environment (MOE) implements various subsidy programs, using revenue from the global warming prevention tax.[3] A way to use its tax revenue effectively is ex-post review of these programs. The ex-post review committee calculates the subsidies for 1 ton of emission reductions (e.g. the policy cost of the emission reduction) and evaluates the co-benefits. Such co-benefits include an improved working environment (e.g. on-site air pollution), enhanced resilience against disasters (e.g. a decentralised power system that can be used for emergencies), improved competitiveness (e.g. through energy cost savings), reduced waste (e.g. through recycling), and a positive impact on the local economy (e.g. procurement from local companies and employment). The monetary value of the co-benefits was estimated, but its value was not generally high following the ex-post review. Table 6 gives an example of the ex-post review.

Table 6: Policy Cost of CO_2 Emission Reduction Subsidies

Program	Cost (¥'000/tCO_2)	Remarks
Incentives for the adoption of advanced technology (for industry, 2015)	2.1	Incentives are provided for the adoption of technology, but reduction is measured by installation or company.
Incentives for the adoption of advanced technology (for non-industry, 2015)	4.2	Incentives are provided for the adoption of technology, but reduction is measured by installation or company.
Geothermal heating (for non-electricity)	31–228	For hotels or houses
Low-carbon transition of town in island	47.6	Improve the resilience of energy security by renewable power as a co-benefit
Energy efficiency of industry	5.2	Mostly small-scale

CO_2 = carbon dioxide, t = ton.
Source: Hongo (2018).

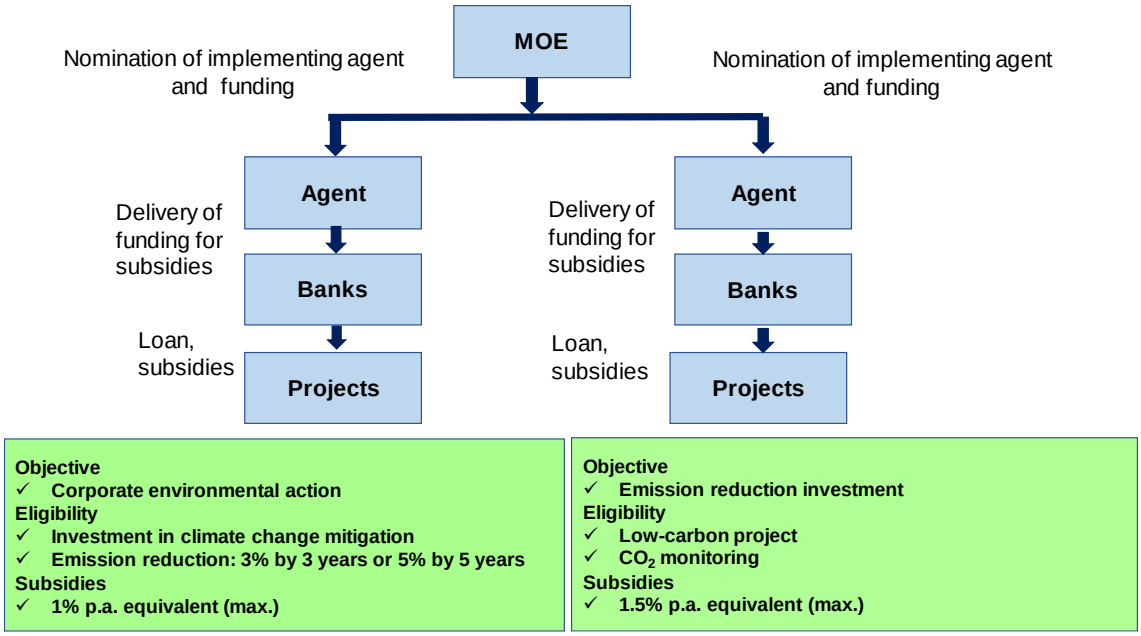
Many programs are implemented by designated implementing agencies and some are implemented by private banks. Subsidies generally fund part of the investment cost and the project owner needs to finance the remaining part through their own funds or

[3] Revenue from the tax is put into a general account, but almost the same amount is allocated to a CO_2 emission reductions program under the national budget.

borrow from banks. It takes time for banks to assess the lending risk if they are not familiar with the project and or the technology. However, mechanisms that provide incentives through banks allow projects to start in a timely manner, since banks are involved in the project from the beginning and have plenty of information about the project and technology (reducing the information gap). A one-stop shop type mechanism is convenient for project development. Under this mechanism, banks provide incentives to projects when the emissions reduction meets the requirements – 3% reduction by 3 years and 5% reduction by 5 years (Figure 1). However, the government budget administrative committee has questioned whether the benefits of subsidies by banks, borrowers, or projects are shared properly, because the main objective of this mechanism is to provide incentives to emission reduction projects for improving the profitability of investment, not supporting the business of banks. This is innovative financing, but it needs improvement.

Another idea for improving the efficiency of subsidies is an outcome- or performance-based incentive scheme which decides the amount of investment based on the reduction in CO_2 emissions.

Figure 1: Structure of Incentives Through Banks



CO_2 = carbon dioxide, MOE = Ministry of the Environment, p.a. = per annum.
Source: Author.

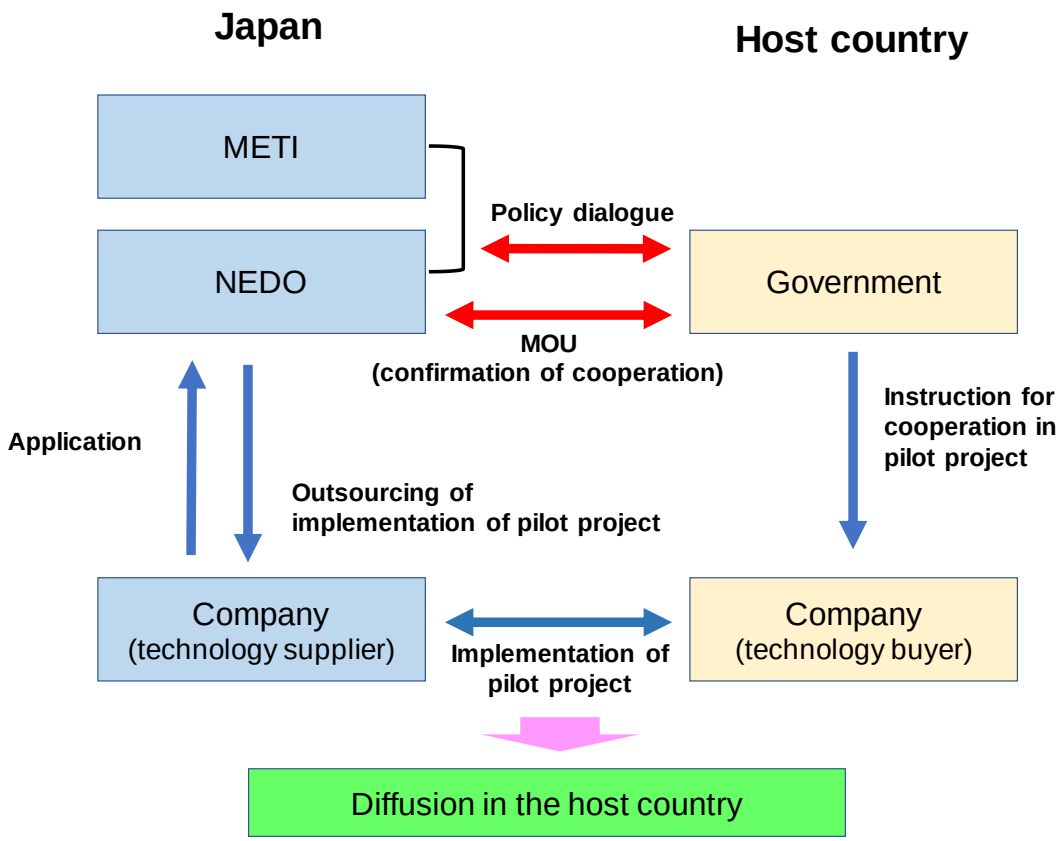
3.2.3. Diffusion of Advanced Technology

The New Energy and Industrial Technology Development Organization (NEDO) is a governmental organisation for promoting the development and introduction of new energy technologies, which plays an important role in technology diffusion.

NEDO uses various approaches. A typical one for international technology diffusion is through demonstration programs (Figure 2). NEDO contracts private companies to implement pilot projects which use advanced technology. A cost-sharing agreement is required with the recipient country's government or partner company, and NEDO pays part of the capital cost of the pilot project. NEDO has a degree of ownership of the projects. When the pilot project is completed, including monitoring of the performance, the private company purchases its equipment at book value after depreciation. The purpose of this program is to test the performance of the advanced technology under different natural environmental and business circumstances and to share its information and experience with host country partners. NEDO supports a specific pilot project but expects many follow-on projects in the host country, and has found that a

decrease in the total costs can be realised through large-scale diffusion of such technologies.

Figure 2: Structure of NEDO International Technology Diffusion Program



METI = Ministry of Economy, Trade and Industry; MOU = memorandum of understanding; NEDO = New Energy and Industrial Technology Development Organization.
Source: Author, using NEDO (2019b) and other information.

NEDO has many successful projects, such as the diffusion of coke dry quenching for blast furnaces and waste heat recovery for cement kilns. The steel and cement industries are typical energy-intensive industries, and energy cost reduction is crucial for improving cost competitiveness, so efficiency improvement has a higher priority. In the case of steel and cement technology diffusion projects, technology suppliers identified local partners in China and developed the market for these technologies together with these partners. In the case of waste heat recovery in the cement industry, a Chinese–Japanese joint venture company is developing foreign markets, including India.

Technology supported by NEDO will not be successful without an enabling investment climate. Energy efficiency regulation varies from country to country. In countries with high economic growth, industries tend to prioritise increasing production rather than energy efficiency. Advanced technology is often isolated in the host country if sufficient energy-efficient regulation is not in place. Table 7 outlines NEDO's risk management guidelines and highlights the importance of the business environment for the diffusion of technology.

Table 7: NEDO Risk Management Guidelines

Type of risk	Checkpoints	Examples
Country risk	Political turbulence, partner risk, legal settings, tax/custom duties	Lack of regulation of energy efficiency, high customs duties for key technology and equipment
Commercial risk (pilot to commercial)	Contract with partners, finance, foreign exchange rate	Low priority on efficiency at partner, limited access to local finance, higher volatility of foreign exchange
Equipment risk	License, site selection, supporting infrastructure/value chain, selection of technology	Higher price of equipment, delay of energy supply such as natural gas, low capacity of electricity grid
Operation risk	Capacity of support at Japanese supplier, including human resources, operational management	Insufficient experience of foreign business (technology supplier)
Domestic risk (Japanese side)	Japanese government policy (policy change), business strategy of technology supplier	Change of supplier's business strategy (business priority)
Diffusion risk	Business model for diffusion, market, standardisation of technology	Absence of local partner, lack of experience of technology standardisation

NEDO = New Energy and Industrial Technology Development Organization.
Note:
1. The types of risks and checkpoints are a summary of NEDO's risk management guidelines (NEDO, 2019a).
2. Examples are based on the author's experience.

Source: Author.

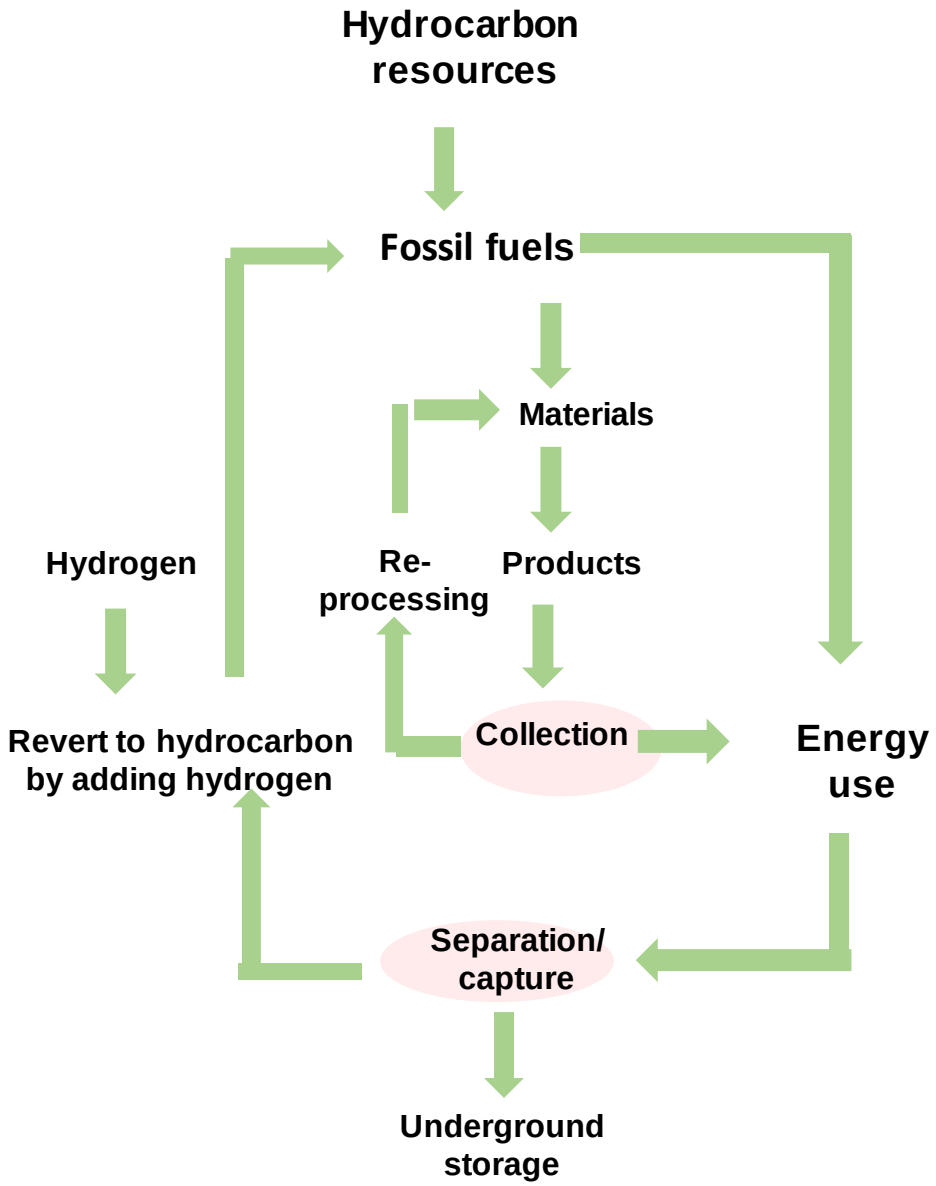
Following the Paris Agreement (United Nations, 2015), many countries will adopt more stringent energy efficiency and CO_2 emissions policies. In 2018, NEDO launched a new policy strategy to increase the emphasis on policy dialogue with host countries for accelerating advanced technology. NEDO requests applicants to submit their programs to

demonstrate the reduction potential from the diffusion of these advanced technologies and the policies needed for such diffusion. The implementation of pilot projects is, in principle, the responsibility of the private company engaged, while NEDO and the Ministry of Economy, Trade and Industry conduct policy dialogue to improve the investment climate by using the experience of the pilot project. This is a measure for reducing the policy gap – e.g. between the current policy and a policy which allows or encourages the use of advanced technologies.

Once the investment climate improves, many follow-on projects may be realised. A remaining concern is the high upfront cost of advanced technology. Therefore, long-term finance is needed. When banks are involved in pilot projects from the beginning, together with technology suppliers, it is easier to obtain funding because the banks are familiar with the advanced technologies.

NEDO points out that the availability of supporting infrastructure should be reviewed as part of the equipment risk. Gasification (as a fuel switch in power and industry) is very common in the Association of Southeast Asian Nations (ASEAN) countries because the natural gas supply network is extending. However, plans and construction are sometimes delayed by a shortage in government funding or gas production development. Another case is the waste collection system for waste power generation. The circular economy – e.g. waste to energy and recycling of materials (Figure 3) – is also becoming a subset of the low-carbon energy transition in ASEAN. Technology is critical but would not function without a collection system. Local governments, which often have weak cash flow, are responsible for collection systems. An important barrier for waste to energy using incineration technology is not the technology itself, but rather the operational know-how and availability of a collection system. NEDO carefully reviews these risks and dialogues with host governments or related parties, as this is beyond the control of NEDO and the implementing agency.

Figure 3: Energy and Material Flow in a Circular Economy Model



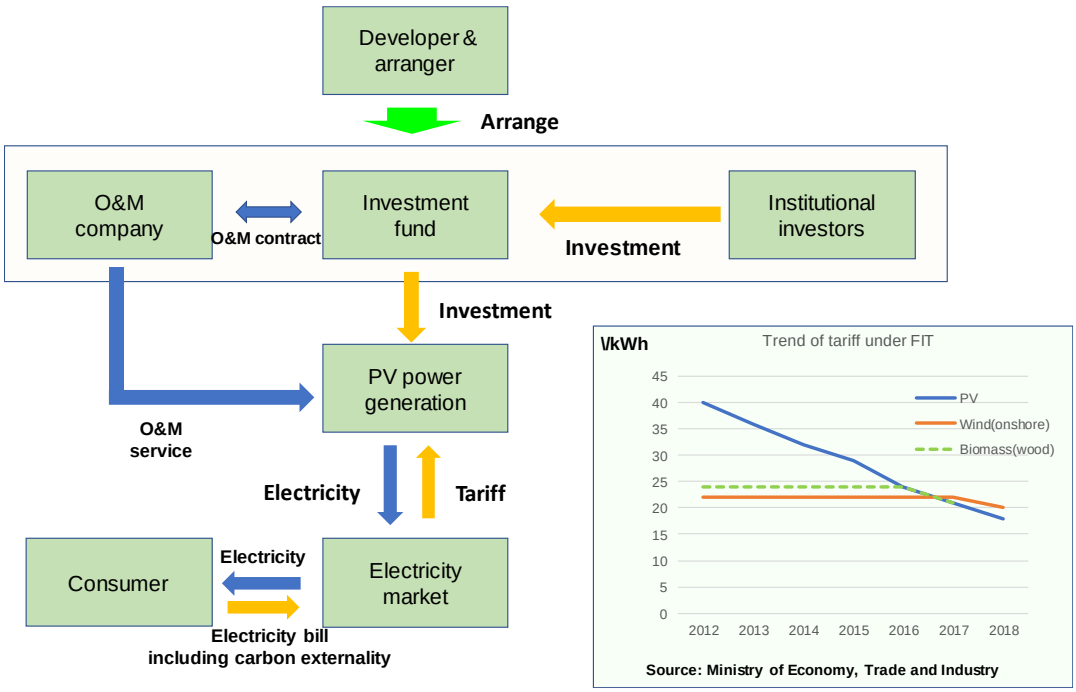
Source: Author.

Banks can finance supporting infrastructure and local partners in addition to project financing. Therefore, the role of banks is important.

3.2.4 Feed-in Tariffs for Renewable Power Generation

Feed-in tariffs (FITs) are often used to encourage renewable energy generation and have succeeded in promoting renewable projects in many countries. Many banks and institutional investors come to this market because technology for renewables is almost proven (low technology risk) and tariffs are predetermined and guaranteed for a long period (stable revenue and low commercial risk), e.g. 10 years in the case of Japan. Tariffs in the FIT system are decided by the government, considering the investment cost and a reasonable profit for investors, so the FITs remove carbon externalities. Figure 4 shows the typical structure of an investment fund in Japan. The bank is the arranger or investor in the fund in this scheme.

Figure 4: Structure of Investment Fund Under FITs



FIT = feed-in tariff, kWh = kilowatt-hour, O&M = operation and maintenance, PV = photovoltaic.
Source: Author, based on various sources; tariff graph based on METI (2018).

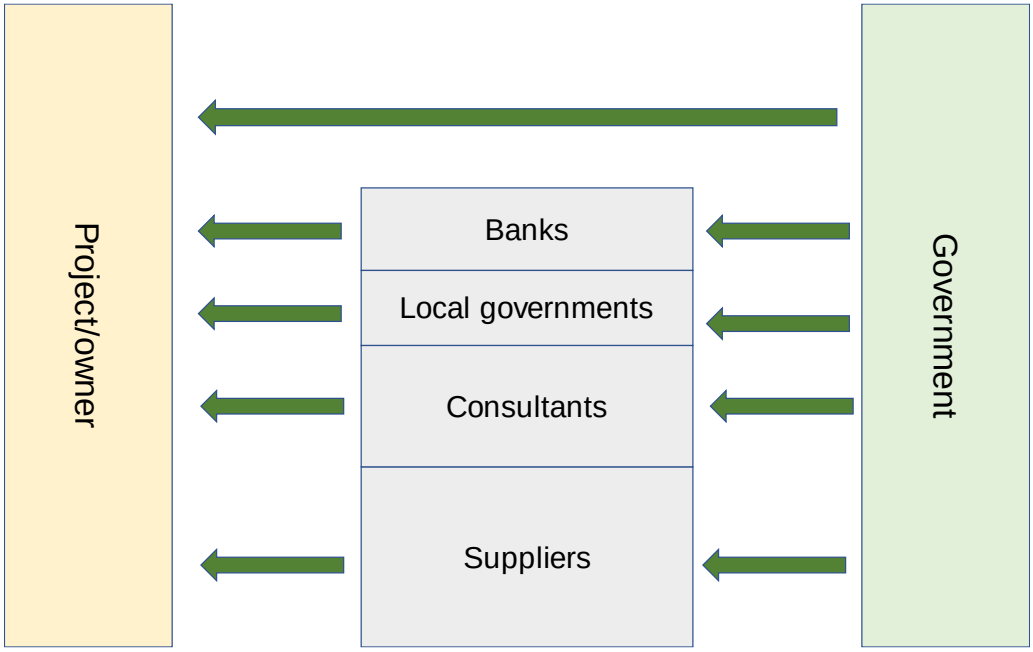
FITs provide a favourable investment climate for banks but place an economic burden on consumers. Tariffs should be adjusted in line with the decreasing cost of equipment, but tariffs sometimes remain high because this scheme does not stimulate price competition. The Government of Japan disclosed that consumers paid ¥2.4 trillion in fiscal year 2018 in additional costs above conventional power generation (METI, 2018), and consumer payments will continue to increase with the upscaling of renewable power generation. To address this challenge, countries like Japan are increasingly using market-based options, such as auctions, to reduce the economic burden on consumers.

3.2.5 Access to Incentive Programs

The government is implementing various incentive programs, each of which has different targets, requirements, and distribution mechanisms. The conditions and processes of these programs are sometimes complex for the applicants of their target investments. The MOE reviews the access channels to these programs – the major channels are equipment suppliers and consulting companies. Equipment suppliers and consulting companies have an interest in specific technology, although many alternative technologies and options are available (Figure 5). Local authorities and banks are neutral to all technology options. Banks take on project risks when they finance investments, so they are motivated to choose the best available technology amongst various options. However, banks are conservative in using new technology.

Access to information on incentive programs for local companies is generally limited, particularly when the programs have complicated processes or are new. If locally operated banks introduce such incentive programs to these companies, it is supportive for these companies. It is also good for the banks because many of these locally operated banks are seeking new green lending opportunities. Therefore, this would bring dual benefits.

Figure 5: Information Channel of Incentive Programs



Source: Author.

3.3. Voluntary Private Finance Activities

3.3.1 Emerging New Approach

Since the Paris Agreement, institutional investors have been seriously considering the risk of climate change and have become more active in voluntary contributions. Industry and local governments are also eager to emphasise their contribution by connecting funding with climate-related effects. This is the background to the increase in climate- or environment-related funding such as green bonds; climate bonds; and environmental, social, and governance (ESG) investment.

ESG investment has three criteria: environmental, social, and governance. The Global Sustainable Investment Alliance reports on the growth of the ESG market (Table 8). The European Union, the United States, and Canada lead ESG investment, with 95% of the global market, but the Asia-Pacific region is increasing rapidly. One-third of ESG investment is through bonds and two-thirds is in equity. ESG investment reviews company activities and strategies. Green infrastructure can be funded by ESG investment.

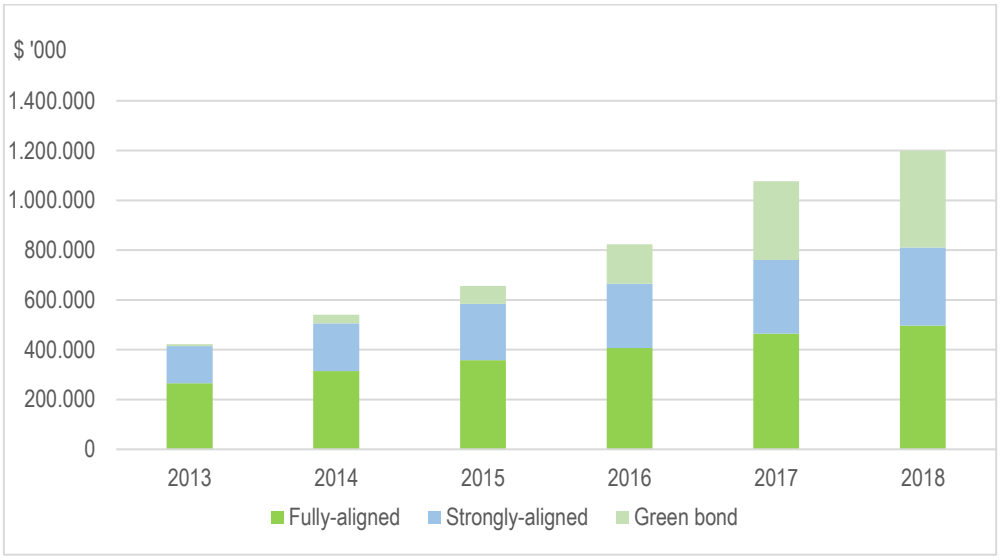
Table 8: ESG Investment Market

Market	ESG amount 2014 ($ billion)	ESG amount 2016 ($ billion)	Share of ESG 2014 (%)	Share of ESG 2016 (%)
European Union	10,775	12,040	58.8	52.6
United States and Canada	7,481	9,809	19.2	23.4
Australia and New Zealand	148	516	16.6	50.6
Asia (excluding Japan)	45	52	0.9	0.8
Japan	7	474	-	3.4
Total	**18,276**	**22,890**	**30.2**	**26.3**

ESG = environmental, social, and governance.
Source: Global Sustainable Investment Alliance (2017 and 2019).

Green bonds finance investments or projects which satisfy their requirements, although they are provided based on corporate creditworthiness.

Figure 6: Growth of Green Bond Market



Source: Climate Bonds Initiative (2018a).

The Climate Bonds Initiative publishes regular market development studies. According to the Climate Bonds Initiative (2018a), outstanding climate-related bonds totalled $1.2 trillion in 2018, having increased threefold from 2013. 'Fully aligned' refers to more than 95% of revenues being linked to climate-related assets, while 'strongly aligned' means that 75%–95% of revenues should be linked to climate-related assets (Figure 6). Various activities are funded, with transport accounting for 44% and energy 24%. These include railways, motorways, photovoltaic energy, and wind power generation. More than one-third of outstanding bonds are 5–10 year bonds, but nearly one-fourth are bonds in excess of 20 years. Green bonds can finance green infrastructure and are expected to be a good source of funding for green infrastructure.

Japan Exchange Group provides Tokyo pro-bond market services for listing green bonds and social bonds. It introduced the International Capital Market Association Green Bond Principles (International Capital Market Association, 2018) and the MOE Green Bond Guidelines (MOE, 2017) as good practices for listing eligibility. However, the Green Bond Principles and Green Bond Guidelines do not have strict requirements for listing green bonds and social bonds, as they prioritise flexibility to attract new investors. Various new types of investment are expected and, at least at the beginning of the new market, flexibility and inclusiveness are important. However, a balance between flexibility and reliability is essential. Japan Exchange Group recommends issuers to disclose information, such as the use of the proceeds, which is reviewed by a third party. As of 25 December 2018, Japan International Cooperation Agency (JICA) was the only issuer on this platform. JICA is an official development assistance agency, and the proceeds of the bond issued were put into its general account, although a large share of its lending is directed to infrastructure. Therefore, for this bond issue, JICA receives third-party reviews for its annual lending or economic assistance activities because the proceeds of this bond are not tied to specific projects.

Banks are deeply involved in developing voluntary markets such as the green bond market, as both arranger/underwriter and issuer. For instance, the Green Bond Principles, a de facto standard of requirements for green bonds, were established by four banks – Bank of America Merrill Lynch, Citibank, Crédit Agricole CIB, and JP Morgan – and banks, including multilateral banks, have issued green bonds following this principle.

Voluntary private finance activities to support green infrastructure are becoming very active and will have large impacts on green infrastructure investment.

3.3.2 Evaluation and Confirmation of its Contribution

A critical point of voluntary action is how to demonstrate what is 'green' and how to evaluate the 'green contribution'. This is indispensable for voluntary action because the reputation of the bond issuer or investor suffers if they are criticised for 'greenwashing' or 'fake bonds'.

The Climate Bonds Initiative classifies the eligibility of green bonds (Table 9). It does not use MRV because quantification of the climate contribution is not easy for institutional investors that are not familiar with project finance.

Table 9: Eligible Projects for Climate Bonds Initiative Green Bonds

Category	Project type	Eligibility	Remarks
Energy	PV, CSP, wind	△	No more than 15% from non-renewable sources
	Bioenergy	△	80% emission reduction compared with fossil fuel baseline; and source is from sustainable feedstocks
	Hydropower	△	Consider environmental and social risk
	Nuclear	○	
	Coal without CCS	X	
	Coal with CCS	△	100% capture is required
	Gas with/without CCS	△	
Transport	EV and charging infrastructure.	○	
	New road construction	X	
	Bus (electric/hydrogen)	○	Infrastructure for bus is ○ or △
	Train (rolling stock and infrastructure)	○	
	Maritime (vessels)	△	Use of low GHG fuel
	Aviation (aircraft)	-	Use of low GHG fuel
Building	Office, residence	△	Top 15% low emissions in the area
Urban development		△	Top 15% low emissions in the area
Industry	Cement, steel, chemical – primary resources	-	
	CCS	△	100% capture is required
	Processing	-	
	Supply chain	△	

CCS = carbon capture and storage, CSP = concentrated solar power, EV = electric vehicle, GHG = greenhouse gas, PV = photovoltaic.
Note: ○ = eligible, △ = case by case, X = not eligible, - = further study is needed.
Source: Climate Bonds Initiative (2018b).

The Tokyo Pro-Bond Market does not have stringent rules for requirements, as noted above, but urges issuers to disclose their general activities and social contribution. This approach leaves it to the market to evaluate whether a bond is green. The credit risk of JICA's green bond is guaranteed by the Government of Japan. Investors in conventional bonds are not keen to become overly familiar with JICA's activities because they are not directly linked to credit risk and financial return. In the case of green bonds, however, information on JICA and its projects or activities is important for investors and other stakeholders. A third-party review of JICA's green project operations would improve the transparency of its activities (JICA, 2016). This is a by-product of green bonds. Disclosure and leaving the choice to the market is an alternative way of maintaining the quality of green bonds.

3.3.3 Economic and Commercial Benefits

A serious constraint for expanding the green bond market is the economic benefit of green bonds. The reputation of green bonds is good, and they are generally oversubscribed. As Table 10 shows, the oversubscription ratio of green bonds is higher than that of conventional bonds (vanilla bonds). However, many market experts say that the gap in the premium between green bonds and conventional bonds is not significant, and investors tend to invest in green bonds if the risk and return on the green bonds are almost the same as for conventional bonds. This means that the green bond market has a ceiling in terms of magnitude and will be saturated.

There is no authority for 'green' credentials, so third-party verification is crucial. In addition to the direct cost of funding, the cost of third-party verification is an indirect cost that should be considered, particularly when the issued amount is small.

Table 10: Gap Between Green and Conventional Bonds

Item	Oversubscription (€ bond)	Oversubscription ($ bond)	IPT gap (€ bond)	IPT gap ($ bond)
Green bond	2.3 x	3.4 x	–8 bps	–17 bps
Vanilla bond	2.0 x	3.0 x	–7 bps	–14 bps
Gap	+0.3 x	+0.4 x	1 bps	3 bps

bps = basis point, IPT = initial price talk.
Note: Vanilla bonds refer to conventional bonds and the IPT gap refers to the gap in pricing between the IPT and actual pricing.
Source: Climate Bonds Initiative (2018c).

It is essential to ascertain how to use this positive movement of green bonds for a 'game change' by adopting carbon regulation. In addition, if a mechanism for incorporating upside profit, which is realised when carbon regulation is adopted, is built into the terms and conditions of green bonds, the green bond market will keep growing.

3.4 Task Force on Climate-Related Financial Disclosures

The Task Force on Climate-Related Financial Disclosures (TCFD) is an initiative to endorse the disclosure of CO_2 emissions information and analysis of its impact on business, for promoting a low-carbon transition strategy. The TCFD released its recommendations on climate-related financial disclosures in June 2017 (TCFD, 2017). The recommendations are not legally enforceable but they have a significant influence on industry and finance because they were prepared at the request of the G20 Financial Stability Board and reported at the G20 Finance Ministers and Central Bank Governors Meeting in July 2017. Three of the 21 TCFD members are from the banking sector and more than 70 banks participate in the task force as 'supporters' as of 11 July 2019.

The box summarises Chevron (2018), the climate resilience report of a major global oil and gas company in response to the TCFD recommendations. The report reveals Chevron's carbon exposure, strategy, and resilience against the IEA's Sustainable Development Scenario, which is in line with the 2°C target. Many other companies have followed suit and are preparing reports and actions in line with the TCFD recommendations.

The risk posed by climate change to the financial system was crucial to the formation of the TCFD. For example, increased frequency of serious climate-related disasters would affect the international reinsurance market, and a sudden jump in the cost of carbon emission costs would affect the cash flow of many energy and energy-intensive industry companies – depressing the stock market. The TCFD assumes that disclosure is the first step for the transition, as it allows markets to be informed of climate change risks and the impacts of CO_2 regulations so that they can then react with enough information

Two messages for green infrastructure may be derived from ongoing dialogue between the financial sector and industry:

(i) The TCFD requests industry to have its own low-carbon transition strategy, including both risks and opportunities, based on scenario analysis, since there is no one-size-fits-all strategy.

(ii) Dialogue between industry and the financial sector is crucial. Companies involved in energy-intensive projects are familiar with energy and carbon policies and markets, but banks' access to such information is limited, so banks can learn a lot from industry.

The TCFD does not explicitly state what is 'green' infrastructure and how to distinguish it from other types of infrastructure, but it implicitly supports green infrastructure and considers the financing of non-green infrastructure cautiously – thus providing crowd in and crowd finance to green infrastructure.

Box: Chevron's Climate Resilience Report

Section 1: Governance framework

Section 2: Risk management
- (i) Operational risk
- (ii) Physical risk
- (iii) Geopolitical and legislative risk
- (iv) Strategic risk

Section 3: Strategy
- (i) Strategic and business planning process
- (ii) Managing portfolio
- (iii) Resilience against IEA's Sustainable Development Scenario

Section 4: Actions and investments
- (i) Energy efficiency
- (ii) CCS
- (iii) Renewable
- (iv) Methane management
- (v) Managing water resources
- (vi) Innovation

Section 5: Metrics

CCS = carbon capture and storage, IEA = International Energy Agency.
Source: Author, based on Chevron (2018).

3.5 Carbon Market

The carbon market provides a commercial value for reduction outcomes, so the reduction outcomes from green infrastructure can be monetised and improve the economics of green infrastructure when the carbon market is revitalised. In 2009, the CDM mobilised more than $8 billion to developing countries, but the carbon market is now almost nil because of the low demand for offset credits. The Paris Agreement changes the role of the carbon market because all countries have emissions reduction targets and some countries need offset credits for achieving their reduction targets.

Table 11 provides an overview of the carbon offset market in Asia. A variety of programs and standards is categorised into three groups: international offset credits, domestic offset credits, and voluntary credits. The Paris Agreement will determine the rulebook for the international transfer of reduction outcomes for its implementation. Two types of international credits may be used to achieve the commitments: credit generated by the United Nations administration (Article 6.4) and by bilateral cooperation (Article 6.2). The CDM is considered a United Nations administration option, but it has not been decided if the CDM will be implemented under the Paris Agreement because the creation of a new type of crediting mechanism under the Paris Agreement is also an option. The Joint Crediting Mechanism is an example of bilateral cooperation. The rulebook for the Paris Agreement is planned to be decided at the Conference of the Parties (COP25) in December 2019 but it was not concluded. It is expected to be concluded at COP26 in 2020. After that, the necessary infrastructure for international emission trading, such as a registry, will be constructed.

Table 11: Carbon Market (Offset Credit) in Asia

Type of credit	General description	Demand
International offset credit	This is designed to be used for achieving the emissions target under the Paris Agreement, which set two types of eligible credits that can be used for offsetting national emissions – those generated through (i) the United Nations administration and (ii) bilateral cooperation. The Joint Crediting Mechanism is a bilateral cooperation option. The rulebook will be decided in 2020.	Some countries (e.g. Japan, the Republic of Korea, Australia, New Zealand, and Switzerland) need international offset credits. The ICAO also decided to use offset credits for CORSIA, but the eligible programs have not yet been determined.
Domestic offset credit	This is designed to be used for achieving emissions targets but not for international commitments. The J-Credit Scheme and the China Certified Emissions Reduction credits are in this category and will be used for domestic regulation or voluntary offset.	Demand mostly depends on domestic regulation.
Voluntary credit	This is called the voluntary standard or private standard and is not designed for compliance purposes: e.g. VCS, Gold Standard, and ACR.	Mostly voluntary offset purposes, but California and Colombia use private standards for domestic regulation. Some private standards intend to be eligible programs for CORSIA.

ACR = American Carbon Registry, CORSIA = Carbon Offsetting and Reduction Scheme for International Aviation, ICAO = International Civil Aviation Organization, J-Credit = Japan Greenhouse Gas Emission Reduction/Removal Certification Scheme, VCS = Verified Carbon Standard.
Source: Author.

Monetisation of the reduction outcomes of green infrastructure depends on demand. Under the Paris Agreement, several countries (e.g. Japan, the Republic of Korea, Australia, New Zealand, Norway, and Switzerland) are expected to use international offset credits for achieving their reduction commitments, but the magnitude of demand, timing of emerging demand, and type of credits are uncertain.

From a demand point of view, an interesting program is the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) of the International Civil Aviation Organization, which commits to keep emissions from international aviation at 2020 levels (carbon-neutral growth). CORSIA will use offset credits and low-carbon fuels to achieve carbon-neutral growth. It is set to start in 2021 and demand is projected to reach more than 1.5 billion tons by 2030. This is an almost confirmed carbon market and can be a source of incentives for green infrastructure, with two conditions:

(i) CORSIA will use various types of programs and credits which meet its own eligibility criteria, but it is uncertain whether credits from low-carbon infrastructure project will be eligible.

(ii) CORSIA will use low-carbon fuel – (a) biomass and waste base and (b) petroleum base. Low-carbon fuel can be used for offsetting emissions in the same way as credits. The environmental value of low-carbon fuel in terms of emissions is theoretically the same as the price of offset credits. Demand for credits is dependent on the price competitiveness against low-carbon fuel.

4. Lessons Learned

Banks need to consider four crucial elements to support green infrastructure efficiently: the requirements for green infrastructure finance, the technology risk, the economics of advanced technology, and the role of voluntary action.

4.1 Requirements

Green infrastructure criteria are needed for the efficient use of finance and to avoid reputational risk. Table 12 summarises the approach of various mechanisms towards the three high-level requirements recommended in section 2.2: CO_2 emissions reduction, energy access, and sustainable economic growth.

Table 12: Approach Towards Eligibility Criteria

Program/Mechanism	CO_2 reduction (SDG 13)	Energy access (SDG 7)	Sustainable economic growth (SDGs 8 and 9)	Avoid negative impacts
JBIC GREEN (public finance; low financial cost and long-term finance)	Objectively confirmed by J-MRV	Not a main objective but realised as a co-benefit	Determined in the JBIC Act, 2011, which established the JBIC	Review the project's environmental contribution using JBIC's Environmental Guidelines for avoiding negative impacts
CO_2 emission reduction support program by MOE (domestic)	Requirement Objectively evaluated by ex-post review	Evaluated as co-benefit by ex-post review	In line with Government of Japan's policy and regulation	Not explicitly mentioned
Pilot project support by NEDO (international)	Requirement	Not a main objective	In line with Japanese and host country policy	Not explicitly mentioned

Program/Mechanism	CO_2 reduction (SDG 13)	Energy access (SDG 7)	Sustainable economic growth (SDGs 8 and 9)	Avoid negative impacts
	Demonstration of reduction by the project and the market is also required	Demonstration as a co-benefit is required at the application		
Green bond (private voluntary action)	Eligible project list MRV is not a requirement	Not a main objective but better to demonstrate as a co-benefit	Sustainability policy is required	Green Bond Principles require environmental considerations, such as water and land use change
TCFD (recommendations on risk disclosure and dialogue)	Analysis of CO_2 risk and opportunity	Not explicitly mentioned but it reviews the possible contribution in the dialogue	Not explicitly mentioned but it will be reviewed as part of the sustainability strategy	Not explicitly mentioned

CO_2 = carbon dioxide; GHG = greenhouse gas; GREEN = Global action for Reconciling Economic growth and Environmental preservation; JBIC = Japan Bank for International Cooperation; J-MRV = Guidelines for Measurement, Reporting and Verification of GHG Emission Reductions in JBIC GREEN Operation; MOE = Ministry of the Environment; MRV = measurement, reporting, and verification; NEDO = New Energy and Industrial Technology Development Organization; SDG = Sustainable Development Goal; TCFD = Task Force on Climate-Related Financial Disclosures.
Source: Author.

All the mechanisms in Table 12 cover the three requirements although they put the highest priority on CO_2 emissions reduction, while energy access and sustainable economic growth are not usually explicitly required. Energy access is demonstrated as a co-benefit while sustainable development is confirmed in line with the national policy or government mission. In addition to these three elements, programs need instruments for avoiding negative environmental impacts. JBIC uses its Environmental Guidelines for confirming the avoidance of negative impacts, and the Green Bond Principles require environmental sustainability – including pollution control, water use, and land use change. 'Avoid negative impact' is considered a minimum requirement.

Three requirements – emissions reduction, energy access, and sustainable economic growth – appear reasonable. When a project is designed, SDGs could be useful tools for reviewing these elements.

There are two approaches to showing eligibility for green infrastructure: (i) a long list of eligible projects and (ii) MRV (Table 13). The long list approach has a higher degree of predictability but requires interpretation to avoid gaps in understanding. The MRV

approach is objective and neutral, but its burden on applicants is greater than the long list. Both have strengths and weaknesses.

Table 13: Approaches to Distinguish Green Infrastructure

Approach	Strength	Weakness
Long list	Higher predictability for investor or borrower	Further interpretation is needed
MRV	Objective and fair; predictable, depending on MRV guidance	Heavier burden, depending on MRV guidance

MRV = measurement, reporting, and verification.
Source: Author.

Another issue is the link between the purpose of funding and the distribution of funds to the project. JBIC and subsidies programs by the MOE and NEDO specify green infrastructure projects and finance such projects. On the other hand, many green bond and other voluntary funding schemes are based on corporate risk, and the link between funding and the project is not sufficiently clear. In addition, the TCFD focuses on the corporate strategy and is not tied to specific investments. These approaches will support green infrastructure in general, but their impact is indirect.

4.2 Technology Risk

Infrastructure has a long lifetime, so advanced technology should be used for green infrastructure because standard technology soon becomes obsolete. Four types of risk are related to adopting advanced technology (Table 14).

Table 14: Barriers to the Diffusion of Advanced Technology

Type of barrier	Outline	Countermeasures
Information gap	• Performance and reliability of new technology is unknown for buyer • Absence of local partner	• Pilot project • Matching of sellers and buyers
Price gap	• Higher upfront cost • Expensive at the early stage of technology diffusion	• Subsidies for reducing the cost • Economies of scale and learning effect
Policy gap	• Gap in carbon regulation between now and the future • Difference in regulation from country to country	• Adoption of carbon pricing and energy efficiency standards • Harmonisation of standards for cross-border markets, e.g. ASEAN
Supporting system gap	• Weak distribution network of low-carbon energy	• Construction of infrastructure necessary for value chain

Type of barrier	Outline	Countermeasures
	• Lack of supporting infrastructure and system, e.g. waste collection system for waste to energy	• Implementation system with local government

ASEAN = Association of Southeast Asian Nations.
Source: Author.

a) Information Gap

Project proponents are generally conservative in using new technology, even though it is used in mother countries of technology, such as Japan, and has an adequate track record. NEDO supports the implementation of pilot projects to demonstrate the performance of advanced technology at the early stage of diffusion, under the business and natural environmental conditions in the host country, which are different from those of Japan. Showing tangible outcomes is a good way of reducing the information gap.

Banks are also conservative about taking risks with technology because they do not have the appropriate capacity or experience to assess the technology, and technology risks are beyond their control if problems occur. Therefore, they tend to support advanced technology at the full-scale diffusion phase.

Banks can also develop a technology marketplace wherein sellers and buyers find matches, co-finance, or practise risk sharing with local partners. An advantage of banks as intermediaries of technological information is that they are neutral to all technology options and generally have no specific interest in the selection of technology for projects. Banks' long list of technology, prepared in cooperation with technology experts, is a good way to introduce appropriate technology. However, only public banks have successfully taken this approach.

b) Price Gap

The scale of the market drives down the cost of advanced technology, and a positive spiral of price reduction and diffusion is often observed (economies of scale and learning effect). Banks can play an important role at the full-scale diffusion phase.

Banks use subsidies programs to improve the economic viability of green infrastructure. In addition to various subsidies programs, banks are very active in using FIT programs for financing renewable power generation projects. This is a low-risk investment market and it grows quickly. A good outcome is price reduction of renewable

generation equipment from the positive spiral of cost reduction and diffusion. However, a negative aspect is the large burden on consumers. As noted in section 3.2.4, in Japan, consumers paid ¥2.4 trillion in additional charges for renewable power generation under FITs in 2018. Shifting to a market-based incentive system, such as an auction or renewable portfolio system, is necessary.

c) Policy Gap

The government is responsible for policy and banks make a limited contribution. However, banks can participate in the policy process and offer their views on the legal framework since the business model and experience of banks are useful in practical legal settings.

The harmonisation of regulations beyond borders, particularly in ASEAN, is important for achieving economies of scale to reduce the cost of advanced technology.

d) Supporting the System Gap

Hard and soft infrastructure for the value chain, such as natural gas pipelines, is needed. Banks can finance the construction of such infrastructure too. Banks are also expected to provide information on the supply chain of green infrastructure projects by using their business and networks.

A critical concern in ASEAN is the weak cash flow of local authorities, which have responsibility for constructing and maintaining infrastructure such as water and waste collection systems. Therefore, a financial mechanism to support local authorities' cash flow capability is needed.

4.3 Economics

The value of green infrastructure, including the environmental value, is higher than the commercial value under present business conditions and carbon regulations. This means that green infrastructure is often not commercially viable in the current investment climate (Figure 7). Public support, such as a revenue boost or a risk-sharing approach, is needed for the commercialisation and scale-up of the investment in green infrastructure.

(i) **Technology performance risk of advanced technology**. The technology supplier should take this risk if it is at the full-scale diffusion phase. The

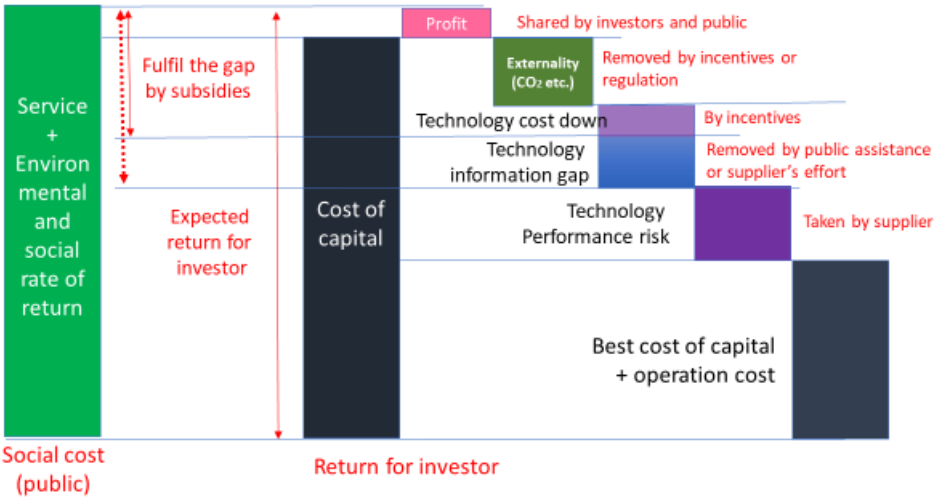
reliability of the performance of early-stage technology can be improved through pilot projects.

(ii) **Technology information gap**. Pilot projects are effective in demonstrating the performance and reliability of advanced technology, and public financial support is essential. Banks can support business matching when proven technology is used.

(iii) **Cost of advanced technology**. The scale of the market drives down the technology cost. Banks can do a lot to support the diffusion of advanced technology, when it is at the full-scale diffusion phase and the technology risk is low, and banks assist in accelerating the cost reduction.

(iv) **Carbon externalities**. Carbon externalities are removed by putting a carbon price on emissions (Figure 7). Subsidies, including a market-based subsidy program such as a carbon market or FITs, improve the economics of green infrastructure projects. Banks can finance projects such as renewable power generation projects under FITs. Changes in policy pose a risk to banks, as subsidies or incentive programs are modified or abolished when projects or investments are feasible without subsidies. Therefore, reducing the FIT or reforming the FIT program, e.g. shifting FITs to a market-based mechanism, is inevitable. However, the upward trend of the cost of carbon is clear, so banks should use this trend to develop an innovative finance mechanism.

Figure 7: Social Cost and Return of Investors



Source: Author.

Banks are generally not familiar with the details of advanced technology, so they expect the supplier to bear the technology risk. However, they can do a lot to lower the cost of advanced technology by financing full-scale diffusion technology projects and acting as an intermediary of technology information. A combination of the technology supplier, government, and banks is the basis for reducing the technology risk.

4.4. Limitation of Voluntary Approach

The supply of funds through voluntary actions such as green bonds is increasing, and this trend will continue. However, the market will be saturated if mechanisms for providing upside profit to the financial product of the voluntary market are not in place. Carbon regulation needs to be adopted. Another method is incentives, examples of which are outlined below:

(i) **Augmented incentives to market mechanism**. Providing incentives to CO_2 emission reduction projects through green bonds, when the reduction is confirmed through MRV.

(ii) **Use of carbon market**. The reduction outcomes of projects financed by green bonds can be monetised when the carbon market is functioning.

(iii) **Tax-exempt base allowance**. A percentage of investment may be put into a tax-exempt base allowance.

(iv) **Reduction of indirect costs**. The standardisation of MRV and third-party verification, including its process, is lowering the barrier for transaction costs. A common ASEAN approach could reduce the learning and implementation costs.

5. Recommendations

5.1. Recommendations to Financial Institutions

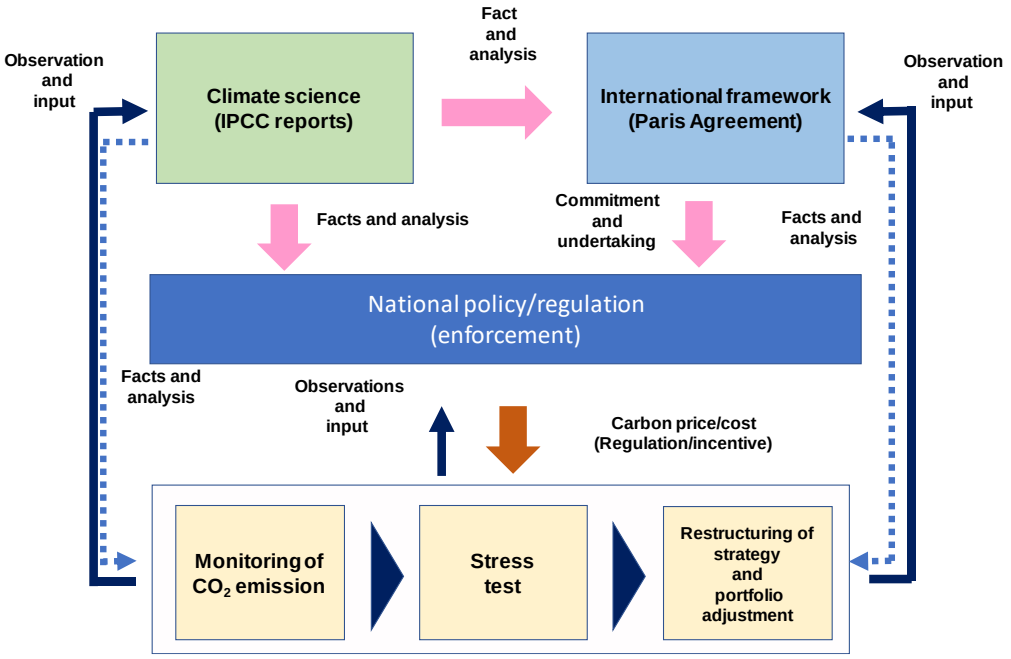
5.1.1. Long-Term Transition Strategy

The momentum for the transition to a low-carbon economy is clear, and green infrastructure is central to it. Financing green infrastructure would be good business for banks. However, because of the speed of the transition, policy measures for enhancing the transition and the necessary green infrastructure vary from country to country. There is no one-size-fits-all strategy for banks, so they should have their own long-term transition scenarios and strategies, tailored to their business environment.

Carbon regulations, which directly affect projects and investment portfolios, will be strengthened, but it is uncertain when or what kind of policies will be adopted. Monitoring of global policy frameworks, such as the United Nations Framework Convention on Climate Change and the Paris Agreement, provide effective preparation for scenario analysis, as national governments need to respond to global frameworks and make efforts to achieve their international commitments. However, it usually takes a long time to reach conclusions. What is an effective way to predict the outcomes of a framework? Scientific analysis, such as publications of the Intergovernmental Panel on Climate Change, is shared as a basis for negotiations by national governments. Therefore, monitoring of global frameworks and the study of scientific analysis are recommended for the development of a long-term transition strategy (Figure 8).

Retaining green infrastructure experts would be beneficial and efficient for banks, but not all of them can do so. Therefore, dialogue with industry and scientific groups is recommended as a supplemental measure.

Figure 8: Low-Carbon Transition and Monitoring of Policy Implementation



CO_2 = carbon dioxide, IPCC = Intergovernmental Panel on Climate Change.
Source: Hongo (2018).

5.1.2. Stress Test Through MRV as Tools for Banks

Banks should review the risks of projects and their portfolios following their long-term scenarios to 2030 and 2050. Scenario analysis for the transition is different from conventional projections because the purpose of production is to obtain the most likely number or pathway – a bottom–up approach – while scenario analysis for industry and banks is a tool for considering what we should do under a different global policy or using a top–down or target-oriented approach. When this focuses on the impact of the business performance using different assumptions, it is called a stress test.

The first thing to do is to quantify the carbon exposure. There are two types of emissions: (i) emissions from energy use (scope 1 and 2); and (ii) emissions from material (upstream), products (downstream), and others (scope 3). Emissions from energy use are likely to be regulated directly but emissions from materials and products are influenced indirectly by the increase in cost or the change in the competitiveness of their products in the market. These two types of emissions should not be mixed up for the consideration of strategy.

A shadow price is needed for the sensitivity analysis or stress test. The IEA's World Energy Outlook[4] and other reports publish global carbon prices, and it is practical to refer to these prices. However, the carbon price that affects business is that of the project implementation country, not the global price, so the carbon price for the analysis should vary by country and sector.

Banks are not familiar with MRV, but stress tests or sensitivity analyses are part of basic banking practice and it is not difficult to incorporate the carbon price in their risk analysis. In any case, not all sectors need to perform a full analysis so it is better to start with the energy-intensive sectors. MRV and stress tests are recommended for banks (Table 15).

Table 15: Risk Control and Opportunity for CO_2 Emissions Reduction

Risks	Present	Medium and long term
Political risk		
Exchange rate fluctuation	• Stable and low risk of fluctuation	• Should take into account cyclical movement of the economy
Lack of regulation of CO_2 emissions	• To some extent, regulation is being implemented and further regulation is being considered.	• Regulation is likely to be more stringent and cover more sectors, but when and how is uncertain. Whether it will be implemented during the project investment period is critical. • Policy change risk from changes in political administration, e.g. suspension of carbon regulation
Lack of effective incentive mechanisms for CO_2 emission reduction	• To some extent, an incentive mechanism is being implemented and further incentives are being considered.	• Incentives are likely to be expanded. • Excessive incentives may be reduced or changed • Shifting to market-based incentives is likely, such as FITs to auctions or the Renewable Energy Portfolio Mechanism
Political turbulence	• Stable and low risk	• Should take into account the demand for democratisation and the widening gap between rich and poor.
Commercial risk		
Market – products	• Stable and low risk • Green products are generally welcomed	• First movers generally reap large profits. • Monetisation of the environmental benefits of green products depends on policy reform • Take into account structural market changes, e.g. the competitiveness of the products is affected by the alternative products
Market – carbon premium	• To some extent, the carbon premium is realised through carbon pricing and it is expected to increase.	• Cautiously consider the volatility of the carbon premium • Market is rather short-sighted (takes time to respond to long-term policy signals)
Energy and material supply	• Stable and low risk	• Impacts from higher carbon price • Price hike of resources for green products

[4] The IEA's annual World Energy Outlook contains energy and CO_2 data, scenario analysis, and a special report. See, for example, IEA (2018).

Risks	Present	Medium and long term
		(resource constraint)
Sponsor	• Generally stable because of economic growth in ASEAN	• Impacts from higher carbon price • Risk of divestment if share of carbon assets is higher
Funding (working capital)	• Stable and low risk (low availability risk)	• Possibility of increased financial cost
Technology risk		
Construction	• Generally stable because of economic growth in ASEAN	• No impact
Performance	• Proven technology is required	• Impact on the operation by technology innovation (positive) • Increased competitiveness through innovation (latecomers enjoy innovation more)
Overall cost/profit	• 'Green' is not cheap so far	• Upside profit is expected, but timing of policy introduction is critical
Reliability	• Proven technology is required	• May improve through innovation (positive) but may be more beneficial for latecomers (risk)
Other risks		
Reputational risk	• Risk is generally not very high • Reputation improves but unlikely to be monetised	• Depends on the speed of the low-carbon transition

ASEAN = Association of Southeast Asian Nations, CO_2 = carbon dioxide, FIT = feed-in tariff.
Source: Author.

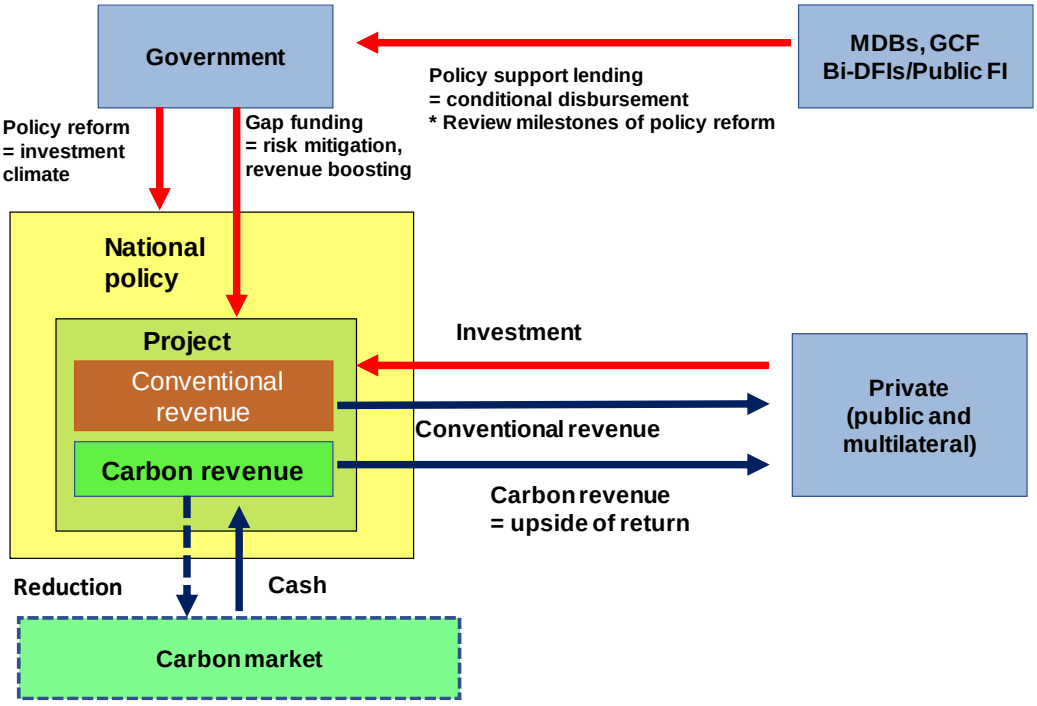
5.1.3 Development of Innovative Finance

Subsidies are a way of removing carbon externalities. An option for improving the efficiency of subsidies is quantifying the reduction cost through ex-post review, which is recommended. In addition to ex-post review, the banking sector is recommended to formulate an outcome- or performance-based incentive mechanism and propose it to governments for implementation. Banks need to improve their MRV skills and should develop simplified MRV through cooperation with industry. JBIC's experience of J-MRV seems to be useful, and cooperation amongst banks for MRV is also recommended. If banks use similar MRV, it also benefits project developers.

The development of innovative finance has significant business potential for banks. A hint for financial innovation is the gap in carbon prices between now and the future. Carbon prices are rising and many new business opportunities, including carbon markets, will emerge. Multilateral banks such as the World Bank and the Asian Development Bank have announced initiatives combining their lending assets and a carbon market for early monetisation of reduction outcomes. This is an example of using the upside potential of carbon pricing for financial institutions. Private banks are expected

to participate in this kind of initiative because policy risk can be mitigated to some extent by the policy dialogue between multilateral banks (or public financial institutions) and host country governments (Figure 9).

Figure 9: Combination of Policy Settings and Finance



Bi-DFI = bilateral development finance institution, DFI = development finance institution, FI = financial institution, GCF = Green Climate Fund, MDB = multinational development bank.
Source: Author – modification of Hongo (2013).

5.1.4. Finance for Soft Landing

Green infrastructure should be increased and mainstreamed. This means that existing infrastructure should be retired as early possible to provide space for green infrastructure. However, this may have negative impacts on the local economy, such as unemployment, so a transition period for restructuring high-carbon intensity infrastructure must be taken into account.

Therefore, it is necessary to phase out higher-carbon infrastructure and establish countermeasures at an appropriate speed to reduce negative impacts on employment and the local economy. Banks are recommended to support the transition cost – both for retiring high-carbon infrastructure and developing new business – to dialogue with the owners of such infrastructure to develop a retirement strategy. Banks should not withdraw

from higher-carbon infrastructure immediately, as this would not support the transition. A soft landing is a more practical and better solution, and is vital to support the transition.

5.2. Policy Recommendations

5.2.1. Carbon Pricing

Voluntary action by financial institutions, such as green bonds, is appreciated and expected to increase. However, the contribution of voluntary action to the green transition at the global level has limitations without commercial benefits because its magnitude is marginal compared with the global financial market. Carbon externalities will be removed through carbon pricing such as carbon taxes, emissions trading, and numerical standards. Banks will respond to the increased carbon price and change their investment strategies. Green infrastructure has a long payback period, so a long-term carbon price signal would be useful to influence the investment strategy.

New regulations which increase costs are generally not well accepted. However, the 'green' momentum may promote the adoption of carbon pricing.

5.2.2 Incentives for Financial Investors

Carbon pricing acts as an incentive for green infrastructure and a disincentive for non-green infrastructure. Additional mechanisms should be considered to encourage financial investors to increase their investment in green infrastructure:

(i) **Deduction of tax on interest from lending to green infrastructure**. A low tax rate on interest, such as withholding tax, for financial investors, including individual investors.

(ii) **Special allowance for investments in green infrastructure**. A non-tax based special allowance for investments in green infrastructure. The economic return on green infrastructure is lower than on conventional investments without sufficient carbon pricing, so this may recover part of the opportunity loss from the investment in green infrastructure.

5.2.3 Subsidy Exit Policy

Subsidies are often used because they change investment behaviour quickly and incur less opposition from the affected entity. However, this carries the risk of spoiling technology innovation, so governments should prepare policies to phase out subsidies from the beginning and put in place a mechanism for reviewing the need for subsidies from the start. A way of adjusting the elements of subsidies, following the progress of technology innovation, is to shift to a market-based approach from a fixed-price approach, e.g. from FITs to auctions. The market can determine the optimal level of subsidies.

To improve the efficiency of implementation, market-based incentive mechanisms such as performance-based incentive mechanisms through banks or reduction purchase funds which purchase reduction outcomes by auction or other rules, should be adopted. When local banks use market-based mechanisms well, this brings triple benefits – for the local economy, local banks, and green infrastructure.

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