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NORTH-EAST ASIA LOW CARBON CITY PLATFORM

Comparative Study on Low Carbon City Development in China, Japan, and the Republic of Korea

North-East Asian Subregional Programme for Environmental Cooperation

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Introduction

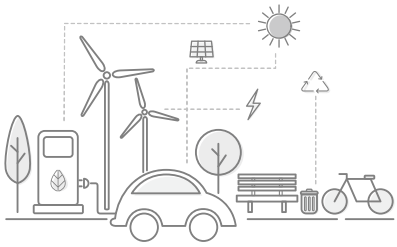
In the face of climate change and rapid urbanization, there is an urgent need for sub-regional cooperation on low carbon city development. North-East Asian (NEA) countries have introduced policies and practices on low carbon city (LCC) development at different levels of government and using various policy tools. There is great scope of available and emerging knowledge and practices for the countries in the region to learn from. In 2015, the North-East Asian Sub-regional Programme for Environmental Cooperation (NEASPEC) launched the North-East Asia Low Carbon City Platform (NEA-LCCP)[1]for cities in the region to share their low carbon practices and learn from each other.

In March 2017, the Twenty-First Senior Officials Meeting of NEASPEC (SOM-21) approved the launch of a peer review and comparative study initiative under NEA-LCCP. The objective of this initiative is to facilitate knowledge sharing, capacity building, and networking among experts and agencies working on low carbon cities in the region. The peer review component of this initiative took a close look at the low carbon practices of Wuhan and Guangzhou, China and Gwangju, the Republic of Korea, and provided these cities LCC planning and policy advice from regional and international experts.

This report analyses and compares the low carbon city policies and practices of China, Japan, and the Republic of Korea, with the goal of identifying sector-specific and city-specific good practices that may be instructive to researchers and policymakers in the wider NEA region. It examines key national-level carbon mitigation policies and sector-specific actions, reviews both top-down and bottom-up low carbon city policy-design and implementation mechanisms and describes fifteen case studies on greenhouse gas (GHG) emission reductions with specific insights. This report will be used in NEA-LCCP information-sharing activities and to promote regional cooperation on low carbon development and climate action.

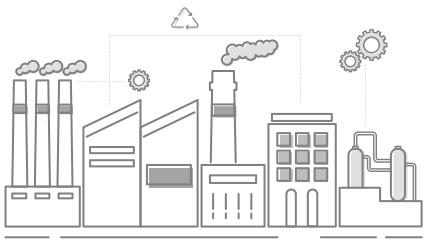
Section One, ***Background*** describes overview of recent emission trends and the underpinning energy structure and energy consumption patterns in China, Japan, and the Republic of Korea and reviews the overall policy framework for low carbon development in these three countries. Section Two, ***Comparative Analysis of Low Carbon City Policy***, examines the similarities and differences in low carbon city policies of China, Japan, and Republic of Korea. Section Three, ***Low Carbon City Policies and Actions*** provides a snapshot of the low carbon policies at subnational level, followed by Section Four, ***Key Sectoral Carbon Reduction Policies***, which summarizes the key sectoral mitigation policies and measures in each country. Section Five, ***Challenges and Recommendations*** identifies common policy challenges faced by all three countries as well as those at the city level. Section Six offers recommendations for new sub-regional actions. Lastly, Section Seven, ***Good Practices***, contains fifteen case studies of low carbon city policy at both the municipal and project levels that could be amplified by cities in and beyond Northeast Asia.

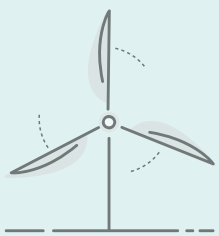
[1] https://www.neaspec.org/sites/default/files/NEA%20LCCP_introduction_1.pdf



PART I

Comparative Study





1. Background

Overview of Recent Emission Trends

To date, total CO_2 emissions of China, Japan, and the Republic of Korea (ROK) together represent over 33% world total emissions and their per capita emissions are well above the world average (Table 1).

Table 1. Total and per capita CO_2 emissions of China, Japan, and the Republic of Korea, 1990-2019

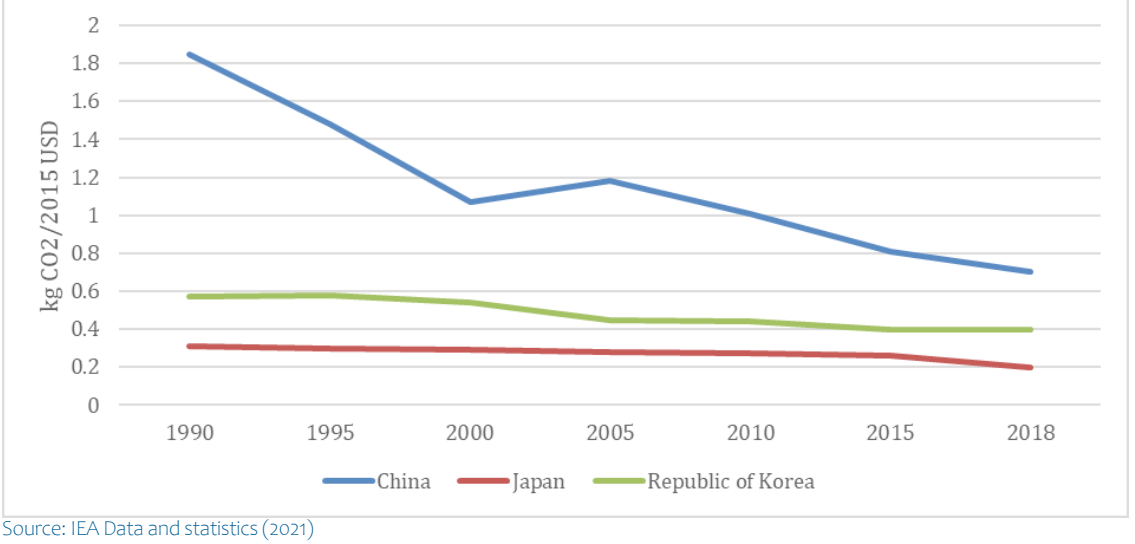
Country	Total CO_2 emission (Mt of CO_2)				CO_2 emissions per capita (t CO_2/capita)			
	1990	2000	2018	2019	1990	2000	2018	2019
World	20,516	23,241	33,513	N/A	3.9	3.8	4.4	N/A
China (mainland)	2,089	3,100	9,528	9,809	1.8	2.5	6.8	N/A
Japan	1,054	1,148	1,081	1,066	8.5	9.1	8.6	8.5
Republic of Korea	232	432	606	586	5.4	9.2	11.7	11.3

Source: IEA Data and statistics, 2021

Note: CO_2 Emissions from fuel combustion only

China records the highest CO_2 emissions among these three countries and worldwide. As its per capita emissions rising in the past decade, China has been decarbonizing its economy through setting up carbon intensity targets to steadily lower its CO_2 emissions per unit of GDP. As a result of the economy-wide emission reduction effort, China achieved significant emission reduction in recent years at a faster pace than planned. Its carbon emissions per unit of GDP during the 12th Five Year Plan (FYP) period (2011-2015) reduced by 20% from the 2010 level, more than the planned target of 17% (Figure 1). Following emission reduction targets set in the National Climate Change Plan (2014-2020) and 13th FYP (2016-2020), China reduced its carbon intensity by 18.2% by 2019, from 2015 levels and 48.1% at 2005 levels, which exceeded its carbon intensity emission targets for 2020 ahead of schedule.

Figure 1. CO_2 emissions per unit of GDP by country, 1990-2018

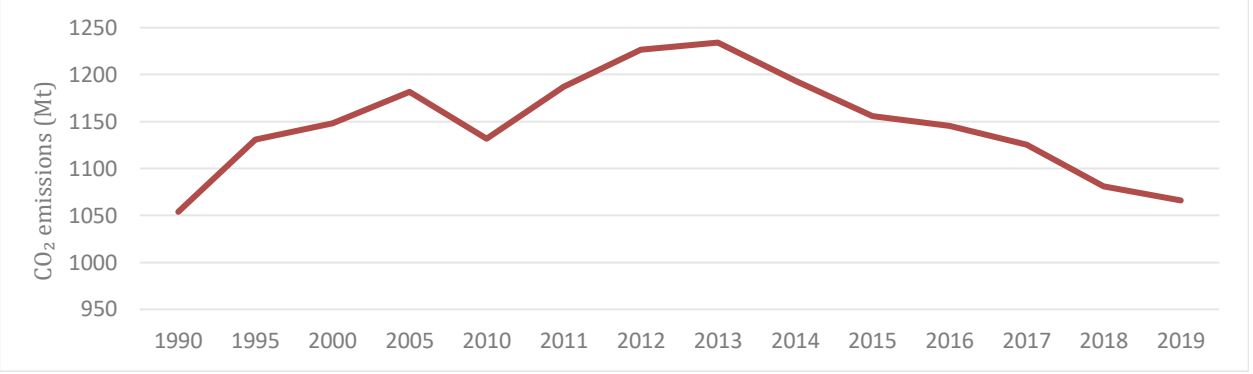


Source: IEA Data and statistics (2021)

Note: CO_2 Emissions from fuel combustion only.

In Japan, CO_2 emissions in the past three decades gradually increased and reached recent peak in 2013, with exception during the global financial crisis in 2008 (Figure 2). The increases of emissions between 2011 and 2013 were related to the Great East Japan Earthquake and subsequent disasters of 2011, which resulted in significant fall of nuclear power generation. The energy demand was substituted by thermal power generation, which drove up the consumption of fossil fuels and thus increased emissions. Total CO_2 emissions have decreased for the sixth consecutive years since 2014, driven by reduced energy consumption primarily in manufacturing industries and the wider use of low-carbon electricity from renewable energy (Japan Ministry of Environment, 2019).

Figure 2. Total CO_2 emissions by Japan, 1990-2018 (Mt of CO2)



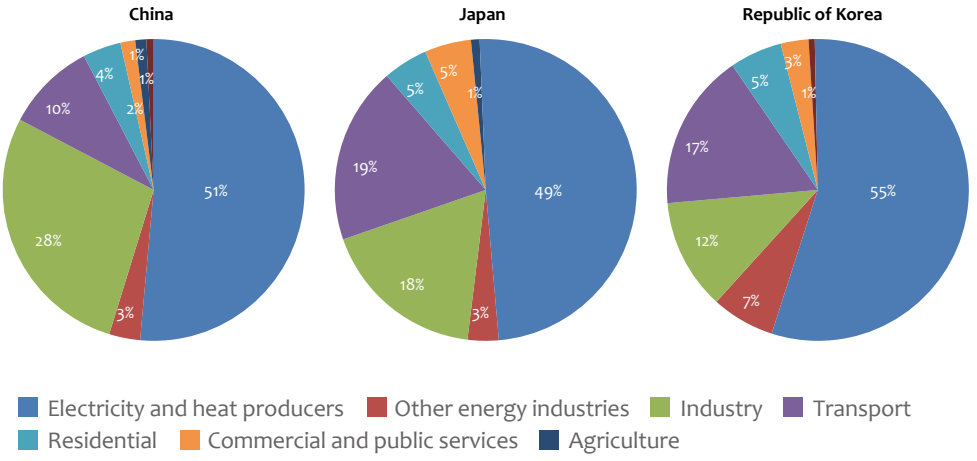
Source: IEA Data and statistics (2021)
Note: CO2 Emissions from fuel combustion only

In the Republic of Korea, total CO_2 emissions continuously increased for decades except during the Asian financial crisis. Nonetheless, the pace of growth of CO_2 emissions have been slowing down. Its per capita emissions increased more than 2.5 times than the 1990 level by 2017 and at a much faster rate than China and Japan in this period. While the per capita CO_2 emission continued to grow except the period affected by the financial crisis, it markedly slowed down in the 2000s. The energy intensity of ROK's economy continued to improve over the decades through energy efficiency improvement and low carbon energy transition. Emissions intensity per GDP decreased by 27% from 1990 to 2017.

Energy sector is the biggest source of CO_2 emissions in these three countries. Emissions from electricity and heat generation accounted for 51% of the total CO_2 emissions in China, 49% in Japan, and 55% in ROK in 2018 (Figure 3).

All three countries submitted their Nationally Determined Contributions (NDCS) under the Paris Agreement. Recently, with their pledges to achieving carbon neutrality by 2050 (Japan and the ROK) and by 2060 (China), there is an ever-stronger call for competitive low-carbon solutions across all economic sectors and taking a whole-of-a-society approach.

Figure 3. CO_2 emissions by sector by country in 2018



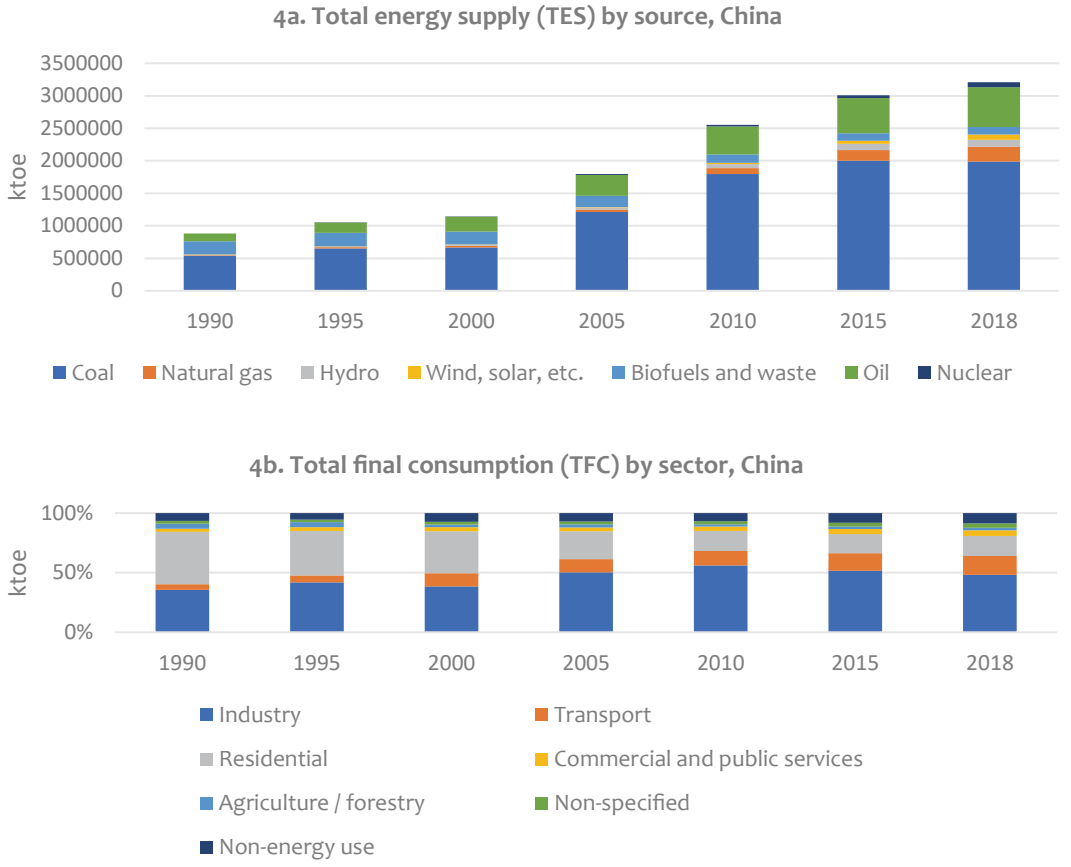
Source: IEA Data and statistics (2021)

Energy Structure and Consumption Patterns

While coal remains to be the dominating source of energy supply for China, Japan and the ROK have diversified their energy sectors with high shares of oil and natural gas in the past decade.

In China, the share of coal in the total primary energy supply remains over 60%, though with a declining trend since 2011 (Figure 4a). Nonetheless, China is undergoing the largest build-out of wind power, hydropower, solar PV and nuclear power. One-quarter of the electricity generated in 2018 by renewable sources, such as wind, hydro and solar, was produced by China.

Figure 4. Total energy supply and total final consumption, China

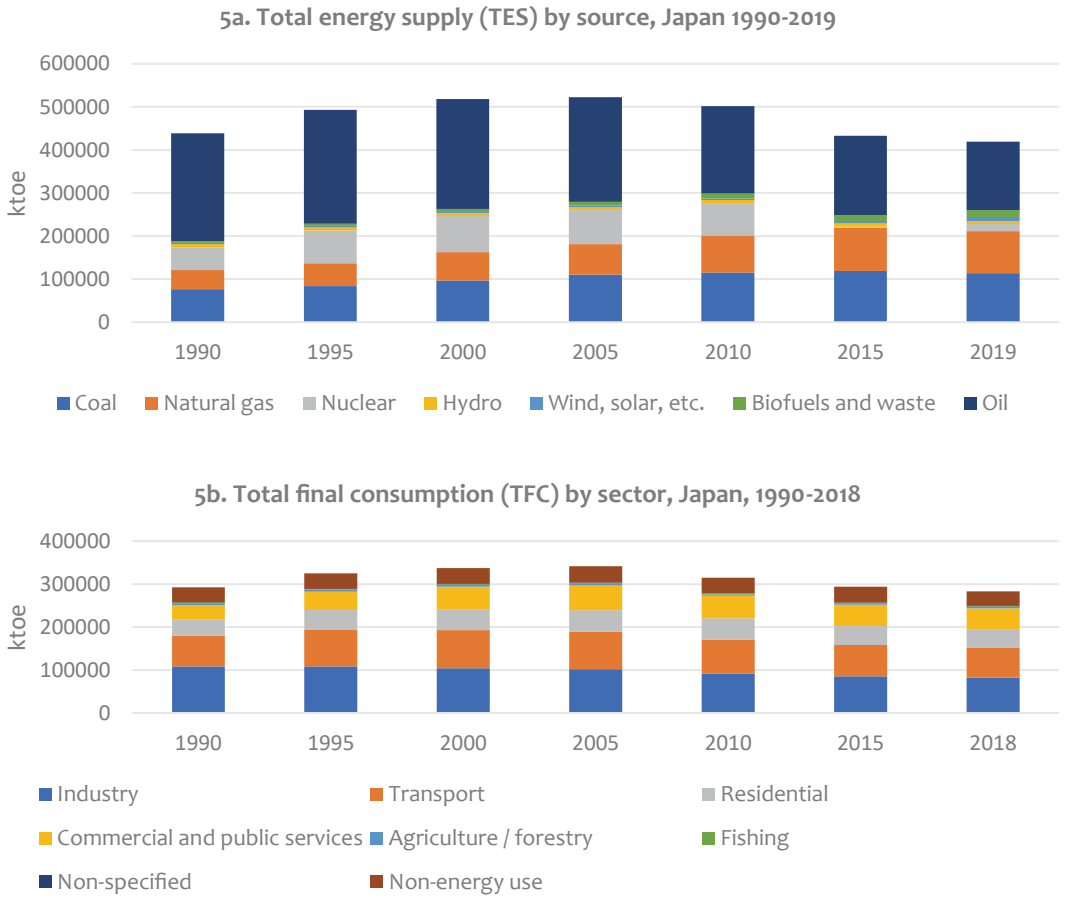


Source: IEA Data and statistics (2021)

China's industry sector is the largest consumer of energy. However, this share has been decreased since 2010 from almost 60% to 49% in 2017 (Figure 4b). China's industrial structure is gradually shifting from energy- and resources-intensive to high productivity one incorporating high technology industries. The energy consumption of the transport sector in China is relatively low comparing with Japan and the ROK. However, as mobility and freight activities rapidly increase with rising living standards, continued industrialization, and ongoing urbanization, final energy consumption of the transport sector rose to 16% in 2017, compared to 11% in 2000 and 5% in 1990. Residential and commercial buildings accounted for around 21% of total final energy consumption in 2017, a growth of 6% from 2010 level, driven by urbanization and rising income.

In Japan, fossil fuels consumption rose to 45% in the fiscal year 2012 following the disasters in 2011 (Japan Ministry of Economy, Trade, and Industry, 2018). Between 1990 and 2018, energy consumption of the industry sector reduced by 24%. Both volume and share of the business and residential sectors' energy consumption increased to 25% and 15% respectively, as of 2018. Advances in energy conservation occurred mainly in the manufacturing industry following the first oil shock. However, the proliferation of energy-use devices and automobiles in the residential and transport sectors resulted in a relatively large increase in energy consumption in these sectors (Japan Ministry of Economy, Trade, and Industry, 2018) (Figure 5).

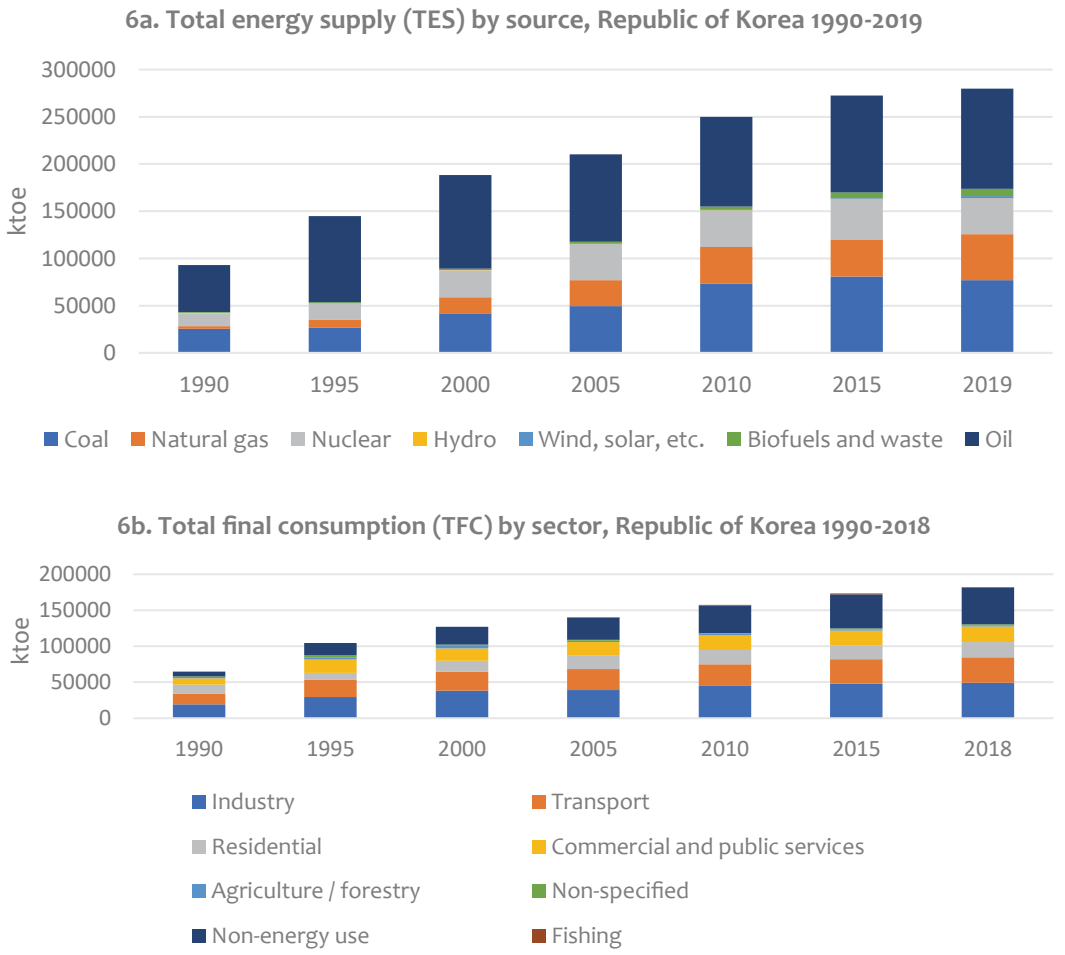
Figure 5. Total energy supply and total final consumption, Japan



Source: IEA Data and statistics (2021)

In the Republic of Korea, total CO_2 emissions continuously increased for decades except for some years. The emissions in 2019 were 2.5 times higher than that in 1990. Nonetheless, the pace of growth of CO_2 emissions has been slowing down. The Republic of Korea has heavily relied on fossil fuels (coal, oil and natural gas) as its primary energy supply, which accounted for about 83% in 2019 (Figure 6a). Coal supplies about 40% of the country's power generation, making CO_2 emissions per capita of the country the highest among the three countries. The industry and transport sectors led final energy consumption growth between 2001 and 2018 (Figure 6b). In 2018, renewable energy accounted for only 2% of Korea's primary energy supply but the government has pledged to significantly boost renewables as part of its Green New Deal, a multibillion-dollar plan to invest in green infrastructure, clean energy and electric vehicles.

Figure 6. Total energy supply and total final consumption, the Republic of Korea



Source: IEA Data and statistics (2021)

Policy framework of low carbon development

In China, the Five-Year Plans (FYP) for Economic and Social Development, which set the overall development strategy including emission reduction targets at the national and local levels, drive the low carbon development efforts in China. The FYP contains both binding and non-binding targets across a range of measures, including carbon emissions and energy use. The National Climate Change Plan (2014-2020) specifies the target of reducing carbon emissions per unit of GDP by 40%-45% from 2005 level by 2020. The 13th FYP (2016-2020) outlines major tasks and sector-specific measures for low carbon development, aiming to reduce its carbon intensity by 18% from 2015 levels by 2020. Most recently, China announced to reduce total carbon emissions per unit of GDP by 60-65% from 2005 levels by 2030, peak carbon emissions by 2030, and achieve carbon neutrality by 2060.

It is worth to note the "target responsibility system (TRS)" to ensure policy implementation mechanism by breaking down and assigning national targets to local governments, which are held accountable

for achieving the assigned target. The TRS is applied for national low carbon development policy implementation to deliver two legally binding targets i.e., energy intensity reduction target and carbon intensity reduction target. To ensure these targets are achieved, China disaggregates them into different quotas for local governments. Achieving these targets is an important indicator for local government and cadre performance evaluation. This creates incentives for local government officials to prioritize energy and carbon intensity reduction in their local policy agendas.

In Japan, the "Act on Promotion of Global Warming Countermeasures" (Global Warming Act) is the basic law for climate change (mainly mitigation) measures and defines the responsibilities of the national and local governments, businesses, and residents. The 2008 revision requires local governments over a certain size (prefectures and cities with a population of 200,000 or more) to formulate action plans to reduce greenhouse gases (GHGs) in line with the natural and social conditions of their area of jurisdiction. The "Plan for Global Warming Countermeasures" issued in 2016 introduced various policy packages, including voluntary, regulatory, economic, and information methods. These policies include 66 policy areas broken down into five areas: (1) GHG emission reduction policies and measures, (2) nationwide campaign, (3) measures taken by municipalities, (4) expected efforts of businesses, particularly those with large emissions, and (5) of global emission reduction and international collaborative opportunities. These policy packages are dominantly economic measures (subsidies and tax cuts) compared to the regulatory measures.

In addition, Low Carbon City Act (latest revision in 2017) is administered by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), which was enacted following MLIT's Environment Action Plan outlining the Ministry's policies towards global warming, low carbon city planning etc.

Republic of Korea's key policy for climate mitigation and low carbon development is the 2010 Framework Act on Low Carbon Green Growth (FALCGG), which is the cornerstone of an innovative national development orientation based on low carbon and green technology for economic growth. Following FALCGG, a sectoral emission roadmap and "Renewable Energy 2030" implementation plan (issued by the Ministry of Trade, Industry and Energy) aim to increase the weight of renewable energy in the power sector from 7% to 20% by 2030. The Republic of Korea's 3rd Energy Master Plan approved in 2019 lays out measures to reform energy taxation and incorporate environmental cost in the power supply system. Guided by these national targets and the roadmap, local governments promote ambitious policies and actions to achieve climate-resilient and sustainable communities. The Republic of Korea also operates a mandatory, nationwide emissions trading scheme (ETS), which was launched in 2015, covering 591 business entities of the country's largest emitters and 69% of total GHG emissions. It includes the direct emissions of six gases from the Kyoto Protocol and indirect emissions from electricity consumption. Participating entities are allowed to use international offsets for up to 5% of their obligations and the first regular emissions auctions took place in January 2019 (ICAP, 2019).

2. Comparative Analysis of Low Carbon City Policy

While there are certain limitations in a direct comparison of experiences among the three countries due to contextual variations[2], low carbon city policies are considered here in two types, depending on whether they are driven by the national governments or local governments, such as cities themselves. Regarding nationally driven policies, this report focuses on three broad categories including: (a) how cities generally fit into national climate policy, (b) support mechanisms for low carbon city development, and (c) pilot and certification schemes. On subnational policy, it considers variation in the activity and ambition of selected cities from China, Japan, and ROK along with their use of three broad policy approaches: voluntary, market-based instruments, and command-and-control tools.

Governance and Institutional Structure

A key point of comparison among cities in the three countries is their fiscal and policy autonomy. The decentralized tax collection, revenue sharing and disbursement structure in China has highlighted the role of subnational governments, which account for about 80% of public expenditure. They are responsible for providing public services, enforcing laws and regulations, and implementing national legislation (Hart, 2019; Kostka & Nahm, 2017). Compared to their counterparts in Japan and ROK, where the structure of governance affords them much less financial and regulatory control, many Chinese cities have the autonomy and capacity to play very direct roles in detailing and implementing policies on low carbon development. At the same time, due to China's top-down planning approach that assigns local governments specific targets on low carbon development, the political room for independent policy innovation on the part of cities is somewhat limited. Japanese and ROK cities, by and large, rely significantly on central government direction and resources. There are some exceptions for large prefectural-level and municipal cities in Japan and ROK. For example, Seoul city has 89% fiscal autonomy compared to only 50-70% for other major cities and far less for smaller cities in ROK (J.-S. Lee & Kim, 2016).

Despite having less financial autonomy, however, ROK, and particularly Japanese cities, have more institutional political leeway in driving their low carbon development. Unlike Chinese cities, those in ROK and Japan do not have sectoral targets handed down to them from the national government. Although, in practice, ROK cities tend to adopt targets that mirror the national ones, Japanese cities show great variation in terms of the target development, suggesting a greater degree of institutional leeway.

[2] Comparative analyses need to strike a balance between systematic, large-N statistical analysis that identify generalizable trends or conclusions, and individual case studies that leverage the rich insights that can be drawn from close analysis of a single observation (Collier, 1991). The experiences of low carbon city development in the three countries vary reflecting their distinct histories, political systems, and socio-economic profiles. Due to such contextual variation, cross-case analysis attempted in this report is mostly drawn from similarities or differences among key variables to try and isolate causal effects (Mahoney, 2007). While not taking a specifically causal comparative approach, this section nonetheless draws on academic principles of comparative analysis and brings structure to bear upon the accounts of low carbon city development in China, Japan, and ROK described in the previous sections.

Institutional aspects

From the perspective of institutional setup, Korean practices are more similar to those of China, where the climate agenda is integral of national development agenda and is more centrally coordinated to mainstream climate change issues into national development strategy. Such approach has resulted central government's direct support to the local climate change mitigation and adaptation efforts in both countries through central government budget financing for local climate actions.

Incentive structures

The different political systems in each country also create interesting variation in incentive structures for city officials. In China, political appointments are made top-down by the central government, meaning officials are incentivized to reach targets and perform to the metrics of the administrative hierarchy. In contrast, Japanese and ROK cities are subject to local public electoral processes. The effect of such a difference depends on the political climate and government objectives at any time. For example, in a situation where local communities have a strong desire for climate action, but top-down government priorities lie elsewhere, incentives to pursue low carbon development would be greater in governance structures such as those of Japan and ROK compared to those of China. In contrast, in the reverse situation, the incentives would be stronger in China as officials are not subject to the immediate demands of public electoral pressure.

Distribution of authority

The distribution of authority and inclusiveness regarding low carbon policy development also vary across the three countries. In China, the National Development and Reform Commission (NDRC) use to play a dominant role in overall economic planning and was in charge of climate change and low carbon development. As a result of the government institutional reform the Ministry of Ecology and Environment (MEE) is leading China's low carbon development efforts and synchronizing the climate agenda with other environmental issues and policies. In Japan and ROK, the Ministries of Environment have already been playing the central role in devising climate and low carbon policy, although some overlap with other ministries still occurs.

Stakeholder engagement

Japan and ROK have institutionalized public mechanisms for stakeholder engagement in the development of low carbon policy. In Japan, corporate groups and organizations, such as federations, play an important role in the policy implementation process. These corporate groups are involved in setting and reviewing the mid-term goals of the country and contribute to related policy planning processes through setting and implementing voluntary mid-term reduction targets. In ROK, the multi-stakeholder National Committee on Low Carbon Green Growth plays a key role in guiding the country's low carbon development. China also consults with stakeholders from industry and non-profit policy research organizations, but these consultation practices tend to be low-profile. In addition, China solicits expert counsel from abroad at both the local and national levels. The China Council for International Cooperation on Environment and Development (CCICED) is an example of a formal organization that is designed to gather input into China's environmental policy broadly.

National-Level Low Carbon City Policy

National governments play a key role in shaping the development of low carbon cities. China, Japan, and ROK have all developed national policy directed towards this end, with variation across a range of dimensions.

The Role of Cities in National Climate Policy Frameworks

Cities' positions in the national climate policy frameworks vary across China, Japan, and ROK. Japan and ROK both have flagship national climate change laws that carve out responsibility for cities to develop their own low carbon/climate mitigation plans, either directly or through the concerned line ministries. China, in contrast, has a flagship climate policy program specifically about cities, i.e., the low carbon cities pilot program. The use of a pilot program approach rather than a more blanket approach, such as Japan and ROK's, reflects a longstanding policymaking tradition in China. Given the large number and wide diversity of local conditions in Chinese cities, developing effective blanket policies is challenging. Pilot programs are designed to generate lessons and information that can later feed into the development of broader national policies. Currently China's pilot approach has covered 87 cities and provinces.

Japan and ROK's climate law frameworks are similar in that they encourage cities to produce local climate action plans but differ in terms of their stringency. In Japan, it is mandatory for cities to produce the type of plan appropriate for their size ("local government implementation plans" or "area plans"). In ROK, on the other hand, creating local adaptation plans is mandatory under the Framework Act on Low Carbon Green Growth (FALCGG), while mitigation plans remain voluntary (Kang, 2019). In China, participation in the pilot cities program is also voluntary in that cities have to put themselves forward to be selected.

The overall frameworks for encouraging low carbon cities can also be compared in terms of their "depth". Japan's "Global Warming Acts" outlines broad areas that cities should focus on (e.g., promoting renewable energy, sustainable lifestyles, and low carbon transport) but provides few specifics on how this should look like. The 2016 revision to the Act does, however, clarify that cities must work towards consolidated urban forms reflecting pressures of ageing and decreasing population. ROK's guidance on voluntary city plans appears to be even less detailed. In China, although a large part of the pilot program's raison d'etre is to allow cities to develop policies and plans based on their unique circumstances, it still gives a number of specific requirements that go further than those stipulated for Japanese and ROK cities. For example, China's pilot cities are required to create GHG inventories and model emissions pathways, create sectoral targets based on the Target Responsibility System (TRS), and, for the third batch, stipulate specific target years for carbon peaking.

Support Mechanisms for Cities

As well as broad frameworks to encourage cities towards low carbon development, China, Japan, and ROK also provide different kinds of support to enable cities in doing so. In China, the government has developed a guideline for provincial and municipal governments to conduct GHG inventories. The national government also provides additional financial support for low carbon city development through grants and

preferential financing. Still, these are for efforts towards achieving centrally mandated FYP targets, rather than initiatives emerging from being a low carbon pilot city (Sandalow, 2018). In Japan, the "Low Carbon City Act" gives more flexibility to the municipalities to develop cross-sectoral low carbon city plans. In addition, the Ministry of the Environment operates a platform to support cities in formulating their plans based upon a survey of the key challenges they face in doing so. It provides a range of manuals and tools for city officials, including examples of plans. In ROK, the Ministry of Environment supports the development of local GHG inventories and low carbon road maps, while the ROK Environment Corporation is in charge of providing capacity building activities for the officials in local governments.

Model City Schemes

Model city schemes are commonly used policy tools that encourage voluntary action and provide frameworks to scale up and learn from the results. As mentioned above, China regularly uses pilot programs as part of national policy development, and its low carbon cities pilot program is its flagship policy for promoting low carbon cities. In addition, China operates a large number of other sustainability-related pilot programs that many low carbon pilot cities participate in concurrently.

These programs are operated by a number of different ministries, including the MEE, NDRC, MOHURD, NEA, MIIT, and MOT (iGDP, 2016). There appears to be a significant overlap between the objectives of these programs. Khanna, et al (2014) argue that this can create administrative confusion and burden that hampers their effective implementation. Similar issues have been identified in ROK, where, although there are fewer pilot initiatives than in China, there are still several programmes with very similar aims operated by different government authorities. This has at times led to conflict among the managing ministries, redundancies, and inefficiencies in expenditure and implementation (Kamal-Choui et al. 2011). However, the range of pilot programs in China may offer greater flexibility to cities as they try to pursue locally appropriate low carbon development (Khanna et al. 2014).

Unlike in China and ROK, Japan's multiple model city certification schemes are hierarchically ordered and managed by the same authorities. The "Eco-Model City" initiative is the primary program that cities can apply for official recognition of their low carbon development efforts. More ambitious action can lead Eco-Model Cities to be progressively recognized as "Future Cities", and by alignment with SDGs as "Local Government SDG Model Cities. The schemes are jointly facilitated by the Ministry of Environment (MoE) and Ministry of Economy, Trade, and Industry (METI) rather than siloed across different parts of the government (Van Berkel, Fujita, Hashimoto, & Geng, 2009). Fewer in number, the scope of Japanese and ROK model city programs are also broader than those of China, encompassing future-oriented issues that are not directly related to low carbon development, such as super-ageing populations and disaster-responsiveness (IGES, 2019; Kamal-Chaoui et al., 2011).

One important similarity across the pilot schemes in all three countries is that they tend not to impose rigid requirements on cities, such as setting specific emission reduction targets. This differs from many of the major transnational city networks, such as C40, which requires members to make a plan by 2020 to align with the Paris Agreement by reaching zero emissions soon after 2050; or Carbon Neutral Cities Alliance (CNCA) which requires cities to commit to reducing GHG emissions by at least 80% by 2050.

Local-Level Low Carbon City Policy

Cities in China, Japan, and ROK also take the initiative themselves in pursuing low carbon city development. Some of this is directly in response to national efforts to promote it, while other manifestations reflect independent leadership emerging at the city level.

Targets and Ambition

An objective overall comparison of the ambition of low carbon development plans in China, Japan, and ROK is difficult due to the variation in development profiles and metrics used for target setting in each country. Chinese pilot cities – many of which are significantly different from those in Japan and the ROK because they are rapidly growing or industrializing – have targets to peak carbon emissions between 2020-2030. In the Republic of Korea, most cities aim to align with the national target of emission reduction, while some cities more ambitious to set their own targets. (Kamal-Chaoui et al., 2011). Japanese cities, in contrast, adopt absolute emission reduction targets. On a nominal level, absolute emission reduction targets are the most ambitious type of target as they exclude the possibility of growth of emissions and have a more objective measurement standard.[3]

The choice of target and target type, however, is often heavily influenced by standards set at the national level. In China, the low carbon pilot cities have targets that are expected to lead the fulfilment of the national target. These cities have targets that are at least as ambitious as the national target and generally significantly more ambitious. In the ROK, whereas there is also a top-down approach to low carbon development and cities have limited fiscal independence, most cities have adopted the national target as their own. In Japan, in contrast, the mitigation targets of cities are generally less ambitious than those of the national government, which may reflect the country's comparatively more bottom-up political system combined with limited city capacity while sectoral policies on low carbon and energy efficiencies include regulatory measures concerning low carbon development of cities, in such areas as building standard and transport.

In terms of the overall share of emissions by cities, it is a common challenge in each country that a significant amount of national emissions come from urban areas. China's first and second batches of low carbon pilots already accounted for 54% of national emissions in 2013 (iGDP, 2015). The number has surely risen with the introduction of the third batch that nearly doubled the total number of pilots. Similarly, the area-wide plans of Japan's larger cities cover approximately 65% of national emissions as of 2018 (IGES, 2019). While equivalent data is not available for ROK, estimates have predicted that 26% of national emissions in 2020 will fall specifically in areas which are under local government jurisdiction to mitigate (Kang, 2019).

While a general comparison of cities across countries is difficult, nonetheless, the few examples illustrate specific, high-ambition cities that have set long-term targets for carbon neutrality or close to it. In Japan, Yokohama, and Tokyo both have goals to have net-zero emissions in 2050[4], while in the Republic of Korea,

[3] There is a movement towards China developing absolute emission reduction targets in the future, which would open doors towards more effectively comparing them with those of other countries. Hu (Forthcoming) provides commentary on how this could be included as part of the 14th Five-Year Plan.
[4] The announcements in 2020 to target carbon neutrality by 2050 (Japan and Republic of Korea) and by 2060 (China) will be translated to local governments efforts. For instance, as of January 2021, 29 metropolitan and prefecture governments in Japan (out of 47 entities) and around 150 cities announced carbon neutrality by 2050. https://www.env.go.jp/en/focus/jeq/issue/vol26/feature.html

Gwangju has done the same. Following the carbon neutrality pledge of China, Chinese cities and local governments are expected to develop local plans to align their low-carbon development. At least 13 Chinese cities that are members of C40 Cities Climate Leadership Group (C40) would be required to do so by 2020 as part of continued membership. In the Republic of Korea, Seoul will face similar expectations as a member of C40.

Cities mostly advance low carbon development through participation in relevant transnational city networks (TCNs). These often provide political, technical, and sometimes financial support for city governments. Participation of China, Japan, and the ROK in the major climate change related TCNs varies significantly. Chinese cities participate heavily in C40 and United Cities and Local Governments World Council (UCLG) WC, while Japanese and ROK cities concentrate their participation in Local Governments for Sustainability (ICLEI) and the Global Covenant of Mayors for Climate and Energy (GCoM). The variation in C40 participation can be attributed mainly to the size of the cities, i.e., China has a large number of "megacities" (the focus of C40) while Japan and ROK have very few. Overall, however, the Republic of Korea and Japanese cities appear to be more actively participating in TCNs.

Overall, it appears that Japanese cities are pursuing the most nominally ambitious agenda due to their focus on overall emissions reductions while, given the respective national contexts, China's low carbon pilot cities are the most ambitious compared to their national government. At an individual level, the most ambitious cities, and the most active cities in TCNs are located in Japan and the ROK.

The announcement to aim for carbon neutrality by the Governments of China, Japan and the ROK during 2020, and push for more ambitious emission targets worldwide, would be translated into the ambitions and targets of the local governments, although the observation of this report mostly refers the policies before 2020.

Policy Approaches

Different approaches to promoting low carbon development in the cities in the three countries often reflect their varied administrative-authority structures described above. Three broad categories of tools that cities employ include voluntary approaches, encourage self-driven action by other actors; market-economic approaches, which use investments and economic incentives to drive action; and command-and-control approaches, which compel action through regulatory authority.

Box 1. Factors affecting the variation of policy approaches

One of the keys to understanding the variation in policy approaches among cities in China, Japan, and the Republic of Korea is the administrative authority and powers that city governments wield. The extent of devolution to city-level governance shapes the potential balance between top-down and bottom-up city climate action. Barriers to policy design, implementation, and monitoring may occur, with all these aspects potentially varying across sectors in line with how power is devolved. This is also a key finding from C40's 'Powering Climate Action' report, which presented a typology of six urban governance that reflect variation in the breadth and depth of city government powers and authorities.

Figure 7. Typology of Urban Governance Structures

Source: Arup & C40 Cities (2015)

Cities bring together different combinations of various characteristics (See Box 1). Furthermore, definitions and administration of cities and local governments differ in all countries. Nonetheless, this framework provides a useful rubric for considering the different ways in which cities do, or could, pursue low carbon development on their own initiative.

In Chinese cities, where local authorities are dominant with their strong fiscal capacities, and top-down decision-making processes, command-and-control approaches are the primary ones used to foster low carbon development (Liu, Matsuno, Zhang, Liu, & Young, 2013). Voluntary approaches, while they are not dominant among China's LCCP's, are deployed in such areas as low carbon transport and industry park pilot projects, promoting zero-carbon buildings, and developing carbon monitoring tools (Wang et al. 2015)

In contrast, cities in Japan and the Republic of Korea rely significantly on voluntary approaches due to their limited fiscal and regulatory authority. In Japan, as at the national level, local governments engage heavily with industry when developing their own low carbon policy as well as supporting and encouraging

voluntary emission reduction efforts across sectors. Japan's Global Warming Act also stipulates that local governments promote emission reduction activities by businesses and residents, including through the use of low GHG products and services (IGES, 2019). In cities of the Republic of Korea, the "Green Start Movement" is illustrative. It is a network of local multi-stakeholder groups supported by local governments that promote low carbon lifestyles through green education and awareness-raising (Kamal-Chaoui et al., 2011). Due to their low cost, voluntary approaches are common for cities in all three countries. As such, they are also relatively more prominent in the overall suite of approaches taken in the cities of Japan and the Republic of Korea, which generally have less policy and fiscal autonomy than major Chinese cities.

As mentioned, there are key exceptions to this difference in autonomy, however, most notably Seoul in the Republic of Korea and Tokyo and Yokohama City in Japan. Due to their economic and political prominence, these mega-cities can more comprehensively promote low carbon activity in their jurisdictions. Seoul stands out in the country as it is a special administrative municipality as the capital of the Republic of Korea and enjoys exceptionally high fiscal autonomy, allowing it to develop and pursue its own initiatives unlike most cities in the country (J.-S. Lee & Kim, 2016). Yokohama and Tokyo similarly stand out in Japan, with the former being the only member among the three countries of the high-ambition Carbon Neutral Cities Alliance (CNCA) and Tokyo being the first city in the world to develop a metropolitan ETS.

Overall, however, the greater decentralization of authority to Chinese cities has also facilitated their greater use of market-based instruments. While command-and-control approaches predominate, as mentioned above, some of China's LCCPs also invest significantly in clean energy development, subsidized loans, and other subsidies (Wang et al., 2015). Most cities of Japan and the ROK lack the capacity and fiscal autonomy to do this at scale. However, some cities have developed interesting incentive programs based on "points" and certification schemes that promote business and household emission reductions. The most prominent market-based instrument would be the development of an ETS. While they are most commonly created at the national level, both Tokyo and Chinese LCCPs have developed ETS at the municipal level. While Tokyo was the world leader in this regard, it remains the only one in Japan, with no ETS emerged at the national level. Seven of China's LCCPs have piloted an ETS and, unlike Tokyo, these are part of a central government scheme to develop an integrated national ETS. No cities in the Republic of Korea operate an ETS as there has been a national-level ETS since 2015.

3. Low Carbon City Policies and Actions

Low carbon city policies and actions in China, Japan, and the ROK vary based on the conditions across each country. These policies include both of those at the national level that specifically target cities, and those that are devised and implemented directly at the subnational level.

China

China's low carbon development planning is largely top-down, with the most important targets being set in the five-year plans and passed down to cities and local governments through the Target Responsibility System (TRS). In some cases, the central government makes funding available to meet such goals, either through grants or preferential financing from the China Development Bank and other policy banks (Sandalow, 2018).

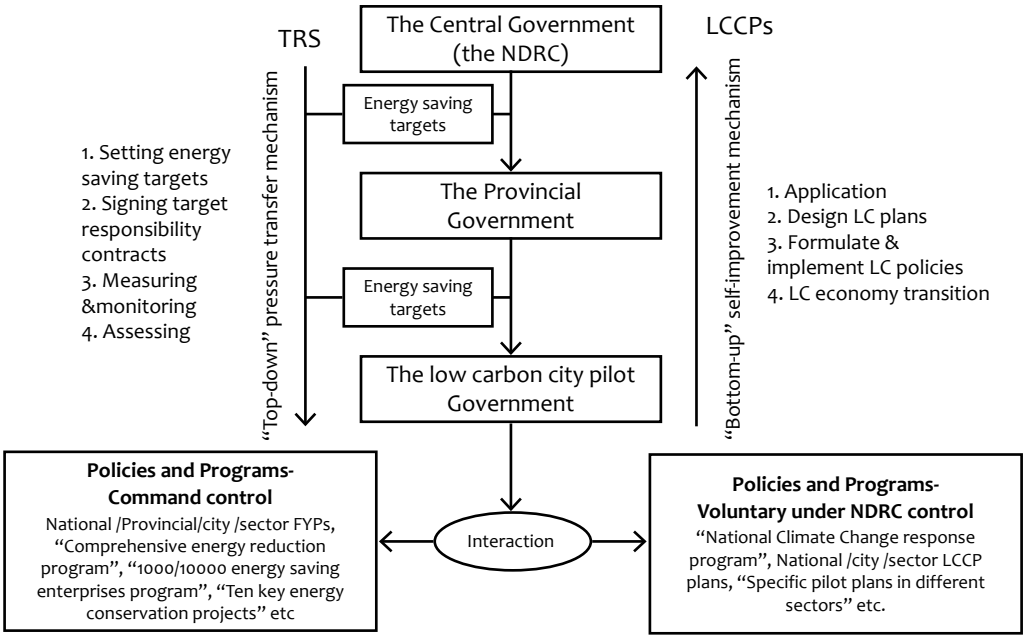
Policies in pilot cities- Low Carbon Pilot Cities

In addition to this general direction and support, China's flagship low carbon city policy is the creation of "Low Carbon Pilot Cities", initially launched by the NDRC in 2010 and carried forward by the MEE after the institutional reform. As of 2018, NDRC has announced **three batches** of low carbon pilots, which now total 81 cities and 6 provinces. Under this program, all pilot cities are required to:

- Draft low carbon development plans and integrate climate change into local five-year plans
- Use a target responsibility system for GHGs emissions control and explore other complementary policies, including market-based mechanisms for policy implementation.
- Support low carbon industrial development
- Conduct a GHG inventory and build a GHG data management system.
- Promote green and low carbon lifestyles through public awareness-raising
  (iGDP, 2019)

Figure 8 depicts how the Low Carbon City Pilots (LCCPs) interact with the Target Responsibility System (TRS).

Figure 8. Interaction between China's Low Carbon City Pilots and Target Responsibility System



Source: Wang et al. (2015)

China's Low Carbon Cities Pilots (LCCPs) (and other cities) employ a range of strategies at the city level to advance low carbon development. They also often set their own, more ambitious sustainability targets. For example, while the national carbon intensity reduction target for 2020 is 40-45%, most of the first and second batch of low carbon pilot cities have targets above these national targets, some as high as 60%, as Wang et al. (2015) highlights. As Chinese cities pursue these targets, they must develop policies and actions that are appropriate for their geography, size, resource endowment, and levels of economic development. All of these factors vary greatly between cities.

As shown in Figure 9, a low carbon pilot city organizes a leading group for municipal low carbon development headed by the mayor and consists of directors of key governmental agencies. Before the institutional reform in 2018, climate change and low carbon policy issues were handled by the NDRC at the national level. Thus, at the local level, the municipal development and reform commissions (DRC) were also responsible for low carbon policy issues, as well as the administration of the local leading group for low carbon development. With the latest government reshuffle, municipal EEBs are in charge of climate policy at the city level and expected to inherit the administration of the low carbon leading group in the LCCPs.

Figure 9. China's Low Carbon Pilot City Administrative Structure

Leading body	Leading Group for the Municipal Low Carbon City Pilot	Headed by Municipal Mayor; Consisted of Heads from Relevant Governmental Agencies; Responsible for guiding the design and implementation of low carbon development plan, as well as coordinating and solving some important issues
Office for Leading Body	Muicipal Development and Reform	Headed by Municipal DRC Director; Responsible for Routine Work of Leading Body, such as Regulatory Institution and Mechanism, Monitoring and Evaluation of Carbon Emission Reduction, International Cooperation and Communication, etc
Coordinating mechanism	Inter-agency Joint Conference	Coordinating the Low Carbon Development Work and Related Policy Research and Decision-Making
Key Participating Agencies	Municipal Development and Reform Commission	Low Carbon Planning, Policies, and Actions on Economic Struture Changes
	Municial Bureau of Energy	Low Carbon Planning, Policies and Actions on Energy
	Municipal Commission of Urban-Rural Development	Low Carbon Planning, Policies and Actions on Buildings and Urban Construction
	Municipal Comission of Economy and Informatization	Low Carbon Planning, Policies and Actions on Industry
	Municipal Commission of Transport	Low Carbon Planning, Policies and Actions on Transportation
	Municipal Bureau of Environmental Protection	Low Carbon Planning, Policies and Actions on Eco-Environment
	Municipal Commission of Urban Management	Low Carbon Planning, Policies and Actions on Waste Treatment and Disposal
	Municipal Bureau of Statistics	GHG Emissions Statistical Data

Source: iGDP (2019)

Japan

Legal/regulatory aspect

While no legal system exists in Japan that binds local governments to create low-carbon cities, the 2008 amendment of 'Global Warming Act' (first enacted in 1998) requires local governments (prefectures and municipalities) to develop "local government implementation plans".

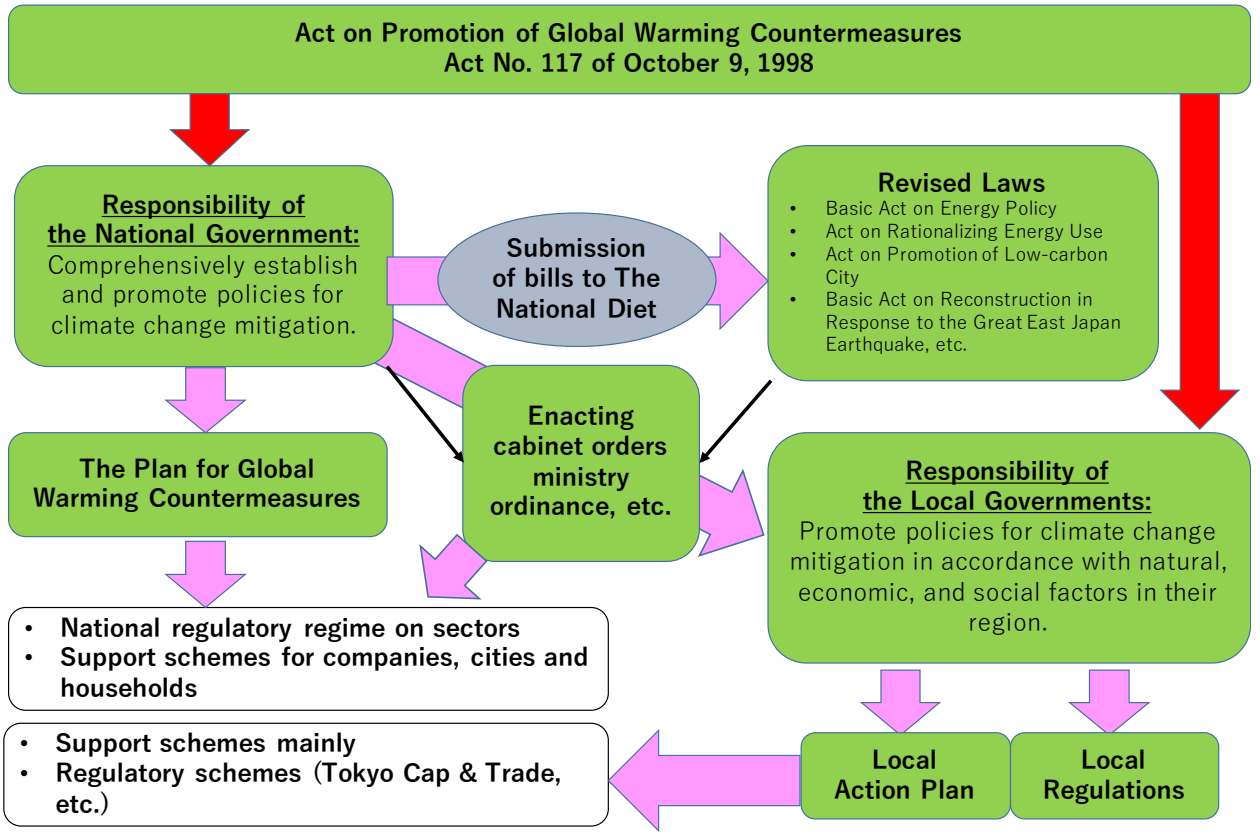
The consequent Low Carbon City Act (Eco-City Act)[5], enacted in 2012, also requires the formulation of low carbon city development plans[6]. The Act aims to promote cross-sectoral emission reductions, providing tax breaks for certified energy-efficient buildings. It helps cities overcome legal and jurisdictional constraints to creating low carbon city plans. The Eco-City Act stipulates that municipalities can formulate "plans to develop low-carbon cities" either alone or jointly, and plans can be formulated together with "local government action plans" based on the Global Warming Act.

[5] http://www.mlit.go.jp/toshi/city_plan/eco-city.html
[6] Ministry of Land, Infrastructure, Transport and Tourism "Low Carbon City Development" https://www.mlit.go.jp/toshi/city_plan/eco-city.html

The plans for cities with populations over 1,700 must guide action towards reducing GHG emissions generated in the process of administrative activities and projects implemented by the local governments. Local governments with populations over 200,000 (47 prefecture-level and 68 city-level governments), however, must produce "area-wide plans" for reducing GHG emission in their entire jurisdiction.

To promote low-carbon development, local governments need to use various legal systems (i.e., deregulation systems) and national support policies (i.e., subsidy systems). Figure 10 provides a schematic view of Japan's climate change policy and the place of cities within it.

Figure 10. Japan Climate Change Policy Framework



Note: Red arrows indicate mandatory obligations under the law. Pink arrows illustrate the flow of how policies are implemented.
Source: IGES (2019)

Local action plans

Cities in Japan have made a range of efforts to follow through on these national directions at the city level, as well as taking initiative themselves. Under the Global Warming Act, as of the end of 2017, 84% of all local governments in Japan, had prepared local government operation plans and all 47 prefectures and 68 cities required to create area-wide plans had done so. In addition, 36 smaller local governments that were not required to prepare such had also voluntarily prepared action plans (IGES, 2019). This activity is further illustrated in Figure 11.

Figure 11. Implementation status of action plan formulation in local governments

Local Government Operation Plan

All local governments are required to formulate, in line with the National Plan against Global Warming (May 2016), their own action plans for GHGs concerning local conditions

Area-wide Plan

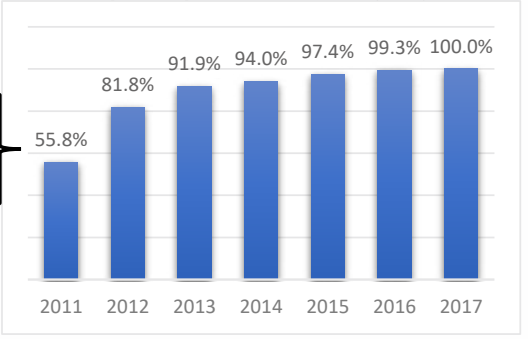
Prefectures and cities with more than 200K population are required to formulate respective area-wide plans, which include 4 categories.

- **Renewable energy facilities**
- **Energy saving efforts by business and citizens**
- **Low-carbon transportation systems, urban green and forest management**
- **Circulation-oriented society**

The number of local action plans (2017)

Type of Local governments	Total	Local Government Operation Plan	Area-wide Plan
Prefectures	47	47 (100%)	48 (100%)
Cities (>500K population)	20	20 (100%)	20 (100%)
Cities (>300K)	48	48 (100%)	48 (100%)
Cities (>200K)	36	36 (100%)	36 (100%)
Other Municipalities (<200K)	1,637	1,349 (82.4%)	343 (21.0%)
Total	1,788	1,500(83.9%)	494 (27.6%)

Area-wide plan implementation rate (2017)



Source: Act on Promotion of Global Warming Countermeasures (Legal framework); Ministry of the Environment. "Survey on the state of legal enforcement of the promotion of global warming countermeasures by local governments: Report on study results (Revised version)", September 2018 (Action plan formulation status).

Note: Prefectures consist of smaller units of local administrations (815 cities, 743 towns and 183 villages), and geographical coverage of the local administrations can overlap (e.g., township < city < prefecture)[7].

Manuals and online platform

The Japanese government also supports cities as they develop their implementation plans. Based on surveys that identified a lack of manpower and expertise as the key barriers, the Japanese Ministry of the Environment has established a platform to support their formulation. It provides manuals and advice on the process for creating plans; calculation and verification tools; databases that are useful in the development of local government plans; information on relevant laws and standards; relevant national subsidy policies; case studies that can serve as references; and links to the more than 1,700 plans that have been published by local governments around the country (IGES, 2019).

Model city development

In addition to this general support for cities to develop their low carbon plans, Japan also promotes low carbon city development through a set of certification programs, including the Eco model city, Future City, SDG Future City, and Local Government SDGs Model Programme. These are systems established by the national government where local governments formulate plans to create model cities that take regional characteristics into account according to concepts and evaluation criteria presented by the national government. The Eco-Model City project is for cities that have been selected by the Cabinet Office as environmental-model cities that are taking ambitious and pioneering actions to create a low carbon society, in order to provide a concrete, easy-to-understand image of the type of low carbon society Japan is aiming to create in the future. Between 2008 and

[7] Japan Agency for Local Authority Information Systems, https://www.j-lis.go.jp/spd/code-address/kenbetsu-inspection/cms_11914151.html accessed on 13 June 2019.

the end of 2018, a total of 30 municipalities have been certified (IGES, 2019).

The Future City Initiative builds on this and selects among Eco-Model Cities for unique success stories in the areas of technology, socio-economic systems, services, business models and urban planning concerning responses to the environment and super-ageing issues. Future cities are eligible for support from the national government in the form of consolidated budgets, regulations, systems, and tax reforms. Between 2011 and 2018, 11 cities were certified as Future Cities (IGES, 2019).

In 2018, the Cabinet Office further developed the "Future City Initiative", launching the "SDGs Future Cities" and "Local Government SDGs Model Programme", incorporating newly adopted SDGs methods. By the end of 2018, 29 cities had been selected as SDGs Future Cities, and of those cities, ten that had particularly advanced initiatives were selected as "Local Government SDGs Model Cities", receiving a subsidy of a maximum of JPY 40 million (Government of Japan, 2018).

The national government has established an online platform for these types of proposed model projects and publishes information on the results of project selection, contents of projects, and related support. In addition, certified cities often have a relative advantage in accessing broader government funding for low carbon activities provided by various government Ministries.

Regulatory support scheme

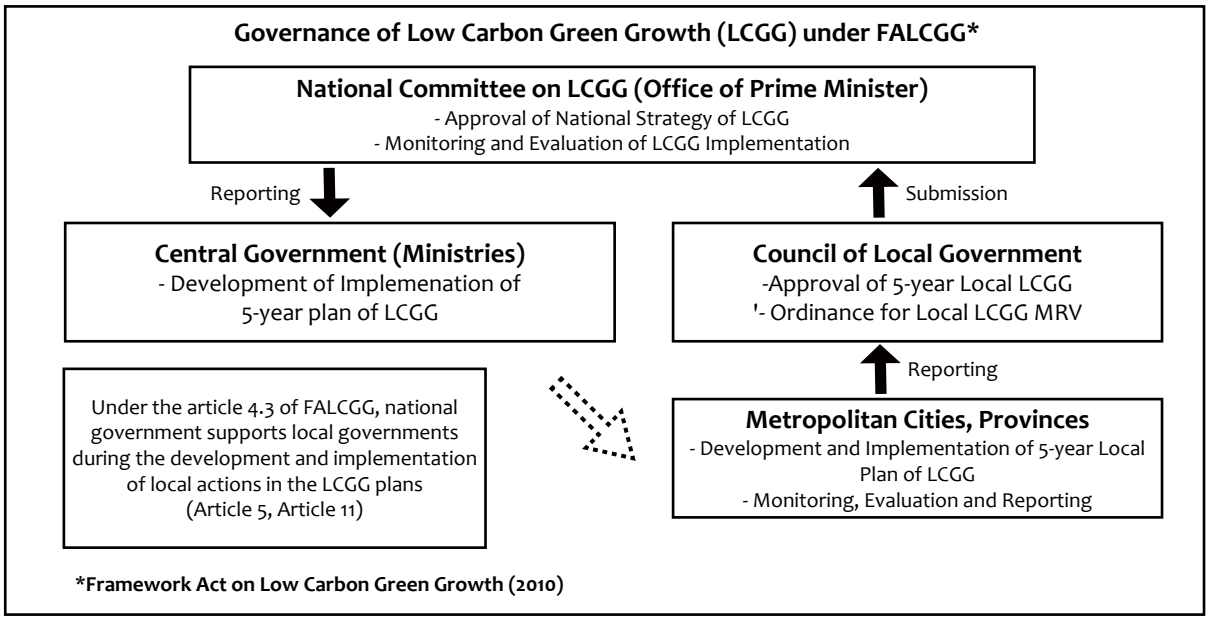
While most cities in Japan are limited in their capacities, some larger cities have taken the initiative to lead ambitious climate action. This includes Tokyo developing the world's first municipal ETS, which is discussed in the best practices section, and Yokohama committing to become carbon neutral by 2050 as part of the CNCA, putting itself on par with the most ambitious cities in the world regarding low carbon development. Cities in Japan also manage some other national schemes, such as a certification scheme for low carbon buildings that offer preferential tax treatment as an incentive.

Republic of Korea

Legal/regulatory aspect

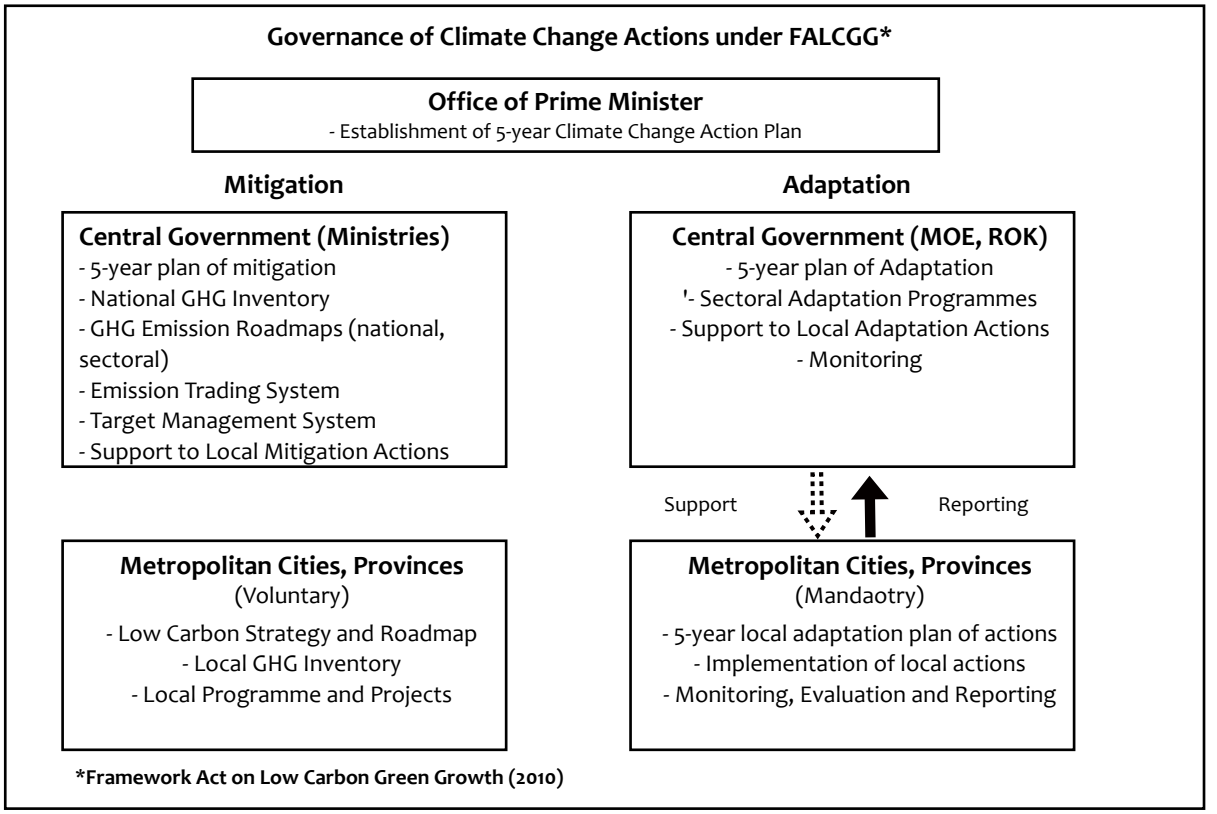
In the Republic of Korea, one of the basic principles of the Framework Act on Low Carbon Green Growth (FALCGG) is mainstreaming low carbon, green growth with all citizens' participation and the cooperation of national agencies, local governments, enterprises, economic organizations, and non-governmental organizations. The act encourages local governments, including cities, to formulate and execute low carbon development plans, including through the establishment of GHG inventories.

Figure 12. Legal Base of Low Carbon Green Growth of the Republic of Korea since 2010



Source: Kang (2019)

Figure 13. National and Sub-national Policy Framework of Climate Change Actions in the Republic of Korea



Source: Kang (2019)

Diverse promotional measures for the development of the Climate Change Action Plan at the city level are delivered by Korea Environment Corporation (KECO) in the mitigation side and by Korea Adaptation Center for Climate Change (KACCC) in the adaptation side. Figure 12 and 13 show the overall structure of local climate action planning in the Republic of Korea. Currently, the development of Local GHG Inventory and Low Carbon Road Map is not mandatory but recommended and supported by the Ministry of Environment. KECO is tasked with providing capacity building activities for the officials in local governments. With support from the central government, most Korean local governments at different level of Korean local administrative governance system have already developed or are developing their own climate action plans. However, the level of detail is different from city to city. Local climate action plans follow the basic structure of the national strategy of low carbon green growth in their principles and sectoral policy components while considering local socio-economic circumstances and characteristics (Kang, 2019).

Financial and human capacity aspects

Central government's financial support for local climate actions proves crucial in Korea, as it provides a substantial political motive for the locally elected city mayors and council members to move onto more ambitious local climate change targets in mitigation and adaptation. In practice, the low carbon city pilot program supported by the central government leads the strategic local vision of more climate-resilient urban development goals in the cities following and benchmarking the pilot cities. Regardless of the central government's financial support to the local climate actions, the lack of the capacity of the local government in the implementation of climate change policy and its action plans comes as the most important challenge for the success of the national-local climate change coordination.

Pilot Low Carbon City programmes by various national agencies

Different agencies of the government of the Republic of Korea have also launched pilot programs to promote low carbon cities, including: the EcoRich City Competition project (Presidential Committee on Green Growth), the Climate Change Adaptation Model City Project (Ministry of Environment), the Green City Project (Ministry of Environment), Eco City Project (Ministry of Environment), Low carbon, Green Village Project (a joint project involving six ministries), and guidelines for low carbon, green cities (Ministry for Land, Transportation and Maritime Affairs). "These projects aim to encourage locally tailored climate change actions and can be a useful tool for testing innovative urban planning strategies and green technological development, such as smart grids" (Kamal-Chaoui et al., 2011, p. 54).

4. Key sectoral Carbon Reduction Policies

This section summarizes the main carbon reduction policies and measures in energy, industry, buildings, and transport sectors in China, Japan and the ROK.

China

Energy

China's low-carbon development policies in the energy sector focus on optimization of energy structure and energy efficiency improvement.

National policies and guidelines: To decarbonize its energy sector, China has been working on transforming its energy structure by promoting coal consumption control, clean utilization of fossil fuels, and development of renewable energy. The Energy Development Strategy Action Plan (2010-2020), issued by the State Council, sets measures to reduce coal consumption. The Natural Gas Development Plan and the Development Plan for Shale Gas guides the exploration of low-emission fossil fuels, while the Opinions on Promoting Safe, Green Exploration of Coal and Efficient, Clean Utilization of Coal, and the Action Plan for Clean and Efficient Use of Coal (2015-2020) is designed to help clean up China's use of coal. The National Energy Administration (NEA) has developed a range of development plans and special plans to support renewable energy development, including hydropower, wind, solar and biomass. In 2016, the Ministry of Finance (MOF), the NDRC and the NEA developed the Interim Measures on the Management of Collection and Utilization of the Renewable Energy Development Fund and the Interim Measures on the Management of the Additional Renewable Energy Surcharge Fund.[8] These policies provide financial support for renewable energy installation.

Energy efficiency standards and labels: China is improving energy efficiency by setting energy efficiency standards/labels and developing energy-efficient technologies. Since 2012, the NDRC has been working with the Standardization Administration to develop the "One Hundred Energy Efficiency Standard Promotion Program". Under this program, more than 100 energy-saving standards have been released. In addition, NDRC, together with other government agencies, has developed policies for energy-saving labelling and certification, such as the "Certification Rules of Energy Management System" and the "Management Measures for Certification of Energy-saving and Low-carbon Products". NDRC has also issued several batches of the Catalogue on the Promotion of National Key Energy Saving Technologies, which lists a wide range of key energy-saving and low-carbon technologies that can be used in different industries. By 2017, it had published 260 key energy-saving technologies in 13 industries.[9]

Industry

China has issued a set of policies and measures to support the de-carbonization of the industry sector, aiming to optimize its industrial structure by upgrading traditional industries, developing strategic emerging industries and service industries, and cutting backward capacity.

[8] National Development and Reform Commission. (2016). China's Policies and Actions for Addressing Climate Change 2016. Retrieved from http://www.greengrowthknowledge.org/sites/default/files/downloads/policy-database/CHINA%29%20China%27s%20Policies%20and%20Actions%20for%20Addressing%20Climate%20Change%20%282016%29.pdf

[9] Ministry of Ecology and Environment. (2018). China's Policies and Actions for Addressing Climate Change 2018. Retrieved from http://english.mee.gov.cn/News_service/news_release/201812/P020181203536441502157.pdf

Upgrading traditional industries: The Guideline Catalogue for Industrial Restructuring, issued by National Development and Reform Commission (NDRC) in 2011 and revised in 2013, emphasizes that China would take a strategic direction toward energy saving and emissions reduction in the industry sector[10]. On the other hand, the Plan for Industrial Transformation and Upgrading (2011-2015) and the Special Action Plan on Green Industrial Development, issued by NDRC, Ministry of Industry and Information Technology (MIIT) and other government agencies, promote the upgrade of key traditional industries. The State Council's "Made in China 2025" includes major tasks to promote energy efficiency and the green transformation of the industry sector.[11]

Developing strategic emerging industries and service industries: The State Council issued the 12th FYP Development Plan on National Strategic Emerging Industries in 2012. It also released, in 2013, the Opinion on Accelerating the Development of Energy-Saving, Environment-Protecting Industries, which places an emphasis on the development of energy-saving and environmental protection technologies. The 12th FYP on the Development of the Service Industry sets out a comprehensive framework to increase the share and quality of the service industry with policy and institutional supports.

Reduce backward production capacity: The State Council issued the Opinions on Curbing Overcapacity and Redundant Construction in Some Industries and Guiding the Sound Development of Industries in 2011. The Guidelines to Solving Serious Production Overcapacity, released in 2013, include set of measures to address overcapacity, such as improving production quality and controlling the growth of new projects.

Buildings

China's low-carbon development in the building sector is centred on promoting building energy efficiency and developing green buildings. Different government agencies have also adopted a set of policies to support building de-carbonization.

The *Special Plan for Conserving Energy in the Building Sector During the 12th FYP*, issued by MOHURD, aims to improve energy efficiency and the use of renewable energy in the building sector. China also revised its Public Building Energy Efficiency Design Standards and requires all newly-built urban buildings to adopt mandatory energy efficiency standards. In addition, China has a "Top Runner" Energy Efficiency Program to identify and promote energy efficiency products, which covers refrigerators, TVs and air conditioners.

The *Green Building Action Plan*, issued by the NDRC and MOHURD in 2013, provides a set of targets and measures to promote green building standards, retrofit existing buildings and encourage the use of green building materials. In 2015, MOHURD published a new Green Building Evaluation Standards that contain stricter requirements on green buildings and sets additional scores for green building technological advancement. In 2017, the Ministry of Housing and Urban-Rural Development (MOHURD) issued the Special Plan for Scientific and Technological Innovation in Housing and Urban-Rural Development during the 13th FYP to further the development of green buildings with an emphasis on building technology.

[10] National Development and Reform Commission. (2013). China's Policies and Actions for Addressing Climate Change 2013. Retrieved from http://en.ndrc.gov.cn/newsrelease/201311/P020131108611533042884.pdf

[11] The National Development and Reform Commission. (2015). China's Policies and Actions for Addressing Climate Change 2015. Retrieved from http://www.cma.gov.cn/en2014/climate/featutes/201511/P020151120633951236905.pdf

Transport

China has also adopted a set of low-carbon policies in the transport sector, particularly in the promotion of public transport and new energy vehicles, to reduce carbon emissions and increase energy efficiency.

The *Guidance on Prioritizing the Development of Public Transport*, issued by the State Council in 2012, sets a comprehensive framework to promote the development of public transport. It identifies several priorities, including infrastructure construction, land use and planning for public transport (the design of bus-only land and busways) and smart transport development. The NDRC's 13th Urban Public Transport Development Plan also encourages actions such as developing non-motorized transport (public bike-only lane, public bike-sharing system). In 2017, the Ministry of Transport (MOT) issued the Implementation Plan for the Promotion of Ecological Civilization in Transport and the Opinions on Comprehensively and Profoundly Promoting the Development of Green Transport, setting the goals and key tasks for the development of green transport.

The *Energy-saving and New Energy Automobile Industry Development Plan*, released by the State Council in 2012, provides policy support for new energy vehicles. It aims to put China's automobile industry on a long-term path toward the development of pure electric vehicles, making the industrialization of pure electric vehicles and plug-in hybrid vehicles as priorities. Meanwhile, MOF's Notice on Preferential Vehicle and Vessel Tax Policies for Energy-Saving and New Energy Vehicles and Vessels provides financial support such as subsidies and tax breaks for new energy vehicles.

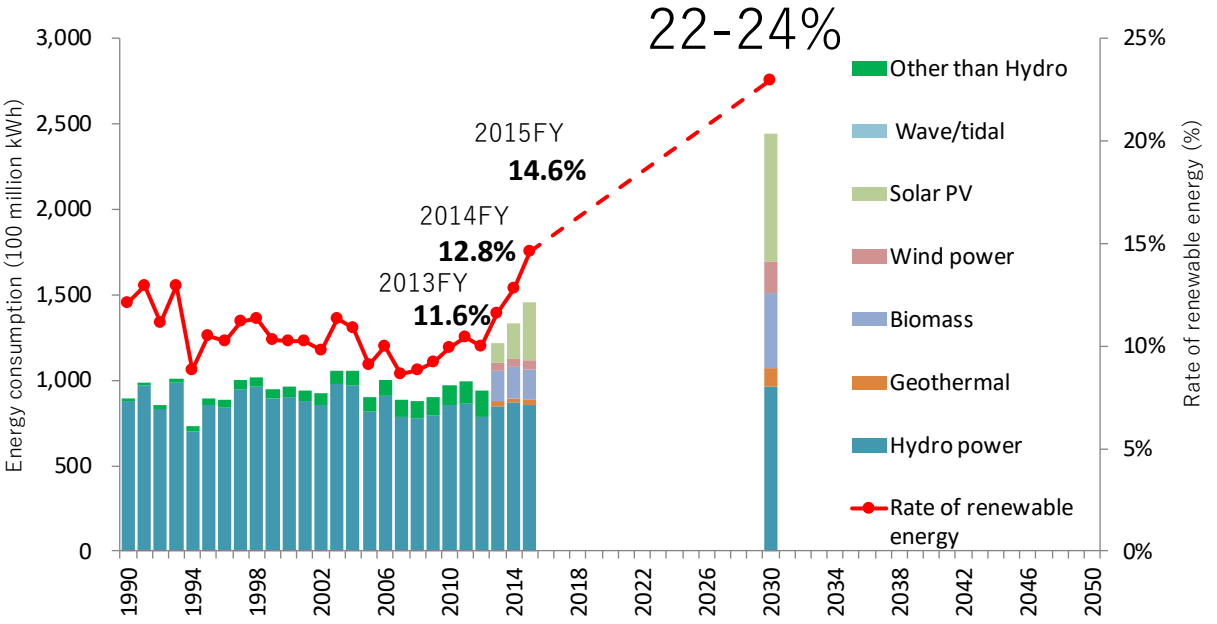
Japan

Energy

In recent years, the quantity of power generation installations for renewable energy and the volume of power generated has rapidly expanded in Japan. The Cabinet decision on the *Plan for Global Warming Countermeasures* in 2016[12] has set the renewable energy generation target to 2030 to between 236.6 billion kWh and 251.5 billion kWh. If achieved, the proportion of renewable energy in the total amount of power generated will expand to around 22% to 24% with an expected CO_2 reduction effect of 160 to 170 million tons (Figure 14).

[12] Cabinet Decision on the Plan for Global Warming Countermeasures [MOE] http://www.env.go.jp/en/headline/2238.html

Figure 14. Long-term supply outlook FY 2030



Source: Ministry of the Environment and Agency for Natural Resources and Energy, 2015

Industry

Measures to address climate change in the industrial sector focus on the "*Act on Rationalizing Energy Use*" (hereinafter referred to as the "Energy Conservation Act"), an energy conservation policy enacted in 1979 following the two oil crises in the 1970s. Under the Energy Conservation Act (latest revision in 2018) mostly administered by the Ministry of Economy, Trade and Industry (METI), factories and business establishments with annual energy consumption (crude oil equivalent) of 1500kℓ or more are subject to the regulation.

These regulated businesses are required to notify authorities about the status of energy use, appoint an energy management supervisor/management plan promotion supervisor and notify authorities, and submit periodic reports on energy conservation actions and medium- to long-term plans (three- to ten-year periods). The business operators that are subject to this act are also required to reduce annual energy consumption intensity by 1% or more on average in the medium to long term. The government can exercise its authority, such as guidance and advice, on-site inspections, and instructions on the submission of improvement plans, in line with the state of energy conservation actions implemented by business operators. If businesses do not comply with these administrative instructions, punitive measures may be taken, such as disclosing their violation, ordering improvements, or imposing fines.

A benchmarking system by sector has been introduced for 11 industries, such as steel manufacturing, cement production, power supply industries, and convenience stores. It is the standards for energy conservation set at the level that is met only by the top 10% to 20% of all businesses (top-runner approach[13]) in each industry. Business operators in the respective industry/area must achieve the standard (level higher than the standard level, plus

[13] The "top-runner" (highest standard achieved) approach compares with minimum standard (such as Minimum Energy Perfornace Standard) and average standard approach. (Reference. Agency for Natural Sources and Energy, METI, https://www.enecho.meti.go.jp/category/saving_and_new/saving/data/toprunner2015j.pdf in Japanese).

standard deviation) in the medium to long term. As of 2018, the benchmark system was aimed to cover 70% of energy consumption in all industries.[14] While business entities in these sectors are not legally obliged to achieve those benchmarks, they are required to prepare reports each year on benchmark improvements that will be submitted to the national governments, which can provide guidance on business activities.

In addition, the "top-runner" system is also applied for 31 types of household equipment and facilities energy-saving equipment, such as transformers, lighting fixtures, and automobiles, refrigerators. According to estimates, the coverage rate for target equipment in top-runner companies is about 70% of household energy consumption.[15] This system sets the energy-saving standard at the best energy-saving performance of the products available in the market at the time of standard-setting and encourages manufacturers to improve the energy-saving performance of the products in the mid-term (3-10 years), such as through capital investment and product development.

If the energy efficiency is considered remarkably low against the standard and requires improvement, the Minister of Economy, Trade and Industry (in cases involving cars, the Minister of Economy, Trade and Industry and the Minister of Land, Infrastructure, Transport and Tourism) issue recommendations to the manufacturer in question. If the manufacturer does not comply with the set recommendations, measures will be taken such as the public announcement of violations, orders and penalties (fines).[16]

Buildings

Global warming measures in the construction sector have been developed mainly on energy conservation measures using the "*Energy Conservation Act*" and the "*Act on Improving the Energy Consumption Performance of Buildings*" (hereinafter referred to as the "Building Energy Conservation Act") as the main rationale. Regulations of energy conservation for buildings (both for business and housing) were transferred to the Building Energy Conservation Act enacted on April 1, 2017, administered by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT).

Under the Building Energy Conservation Act, non-residential building owners must comply with building energy conservation standards set by the national government when constructing new or renovating non-residential buildings that are 2,000m^2 or more. Buildings that do not meet energy conservation standards cannot acquire building certification (Table 2).

Measures to improve the energy-saving performance of new residential buildings by commercial agents below 300m^2 are implemented through the top-runner system while improvement of the energy-saving performance of existing buildings is encouraged through facility equipment (lighting, water heaters, elevators, etc.) and materials (insulation, etc.)

This system includes some financial incentive schemes (tax, subsidies) as well as voluntary schemes such as labelling for energy-efficient buildings and regulation related to permission for maximum floor space per unit of land.

[14] Ministry of Economy, Trade and Industry. "Trends in Energy Conservation Measures", 2017. http://www.enecho.meti.go.jp/category/saving_and_new/saving/pdf/2017_02_shoueneseisaku.pdf
[15] Ministry of Economy, Trade and Industry. "Trends in Energy Conservation Measures", 2018. https://www.kansai.meti.go.jp/3-9enetai/downloadfiles/2018/20190212sesakusetumei.pdf
[16] Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry. "Search Q&A to Support Energy Savings by Companies". https://wwws.meti.go.jp/enecho/saveenergy2/enterprise/faq/qa01.html

Table 2. Act on the Improvement of Energy Consumption Performance of Buildings

(for new construction)	**Non-residential building**	**Residential building**
Large-scale buildings (above 2,000m^2)	Mandatory compliance Mandatory compliance/evaluation for compliance of newly constructed building energy efficiency performance standards (energy efficiency standards)	Mandatory notification Mandatory notification to administrative agencies with jurisdiction of plan for new construction/extension/renovations
Medium-scale buildings (300 to 2,000m^2)	Mandatory notification (Instruction / orders for non-compliance)	(Instruction / orders for non-compliance) Instructions/orders issued when deemed necessary without compliance with standards.
Small-scale buildings (below 300m^2)	Reasonable endeavour (for improvement of energy consumption performance)	Reasonable endeavour -Housing top-runner (standard) Recommendations /orders issued when deemed necessary

Source: MILT https://www.mlit.go.jp/common/001223580.pdf and https://www.mlit.go.jp/common/001134876.pdf

Transport

The *Energy Conservation Act* requires that transport companies with a transport capacity over a certain level (300 railcars, 200 trucks, 200 buses, 350 taxis, 20,000-tonne ships (total vessel capacity), and 9,000-tonne aircraft (maximum takeoff weight)) submit periodic reports on transport capacity, energy conservation efforts as well as medium- and long-term plans for improvement of energy efficiency.

Business operators that are subject to this act are also required to reduce energy consumption intensity by 1% or more on average over the medium to long term.
In addition to the above, shippers who use transport companies to transport cargo more than 30,000 ton-kilometres (weight x distance) per annum are also subject to regulations and are required to submit periodic reports on the status of energy use and planning documents on energy conservation efforts.

Based on the contents of periodic reports submitted by specified transport companies and target shippers, the national government may collect reports or carry out on-site inspections to confirm compliance with assessment standards and changes in energy consumption intensity. In some cases, the national government may also submit recommendations, publications, or orders if they recognize that there are significant insufficiencies in the rational use of energy in light of assessment criteria.

Republic of Korea

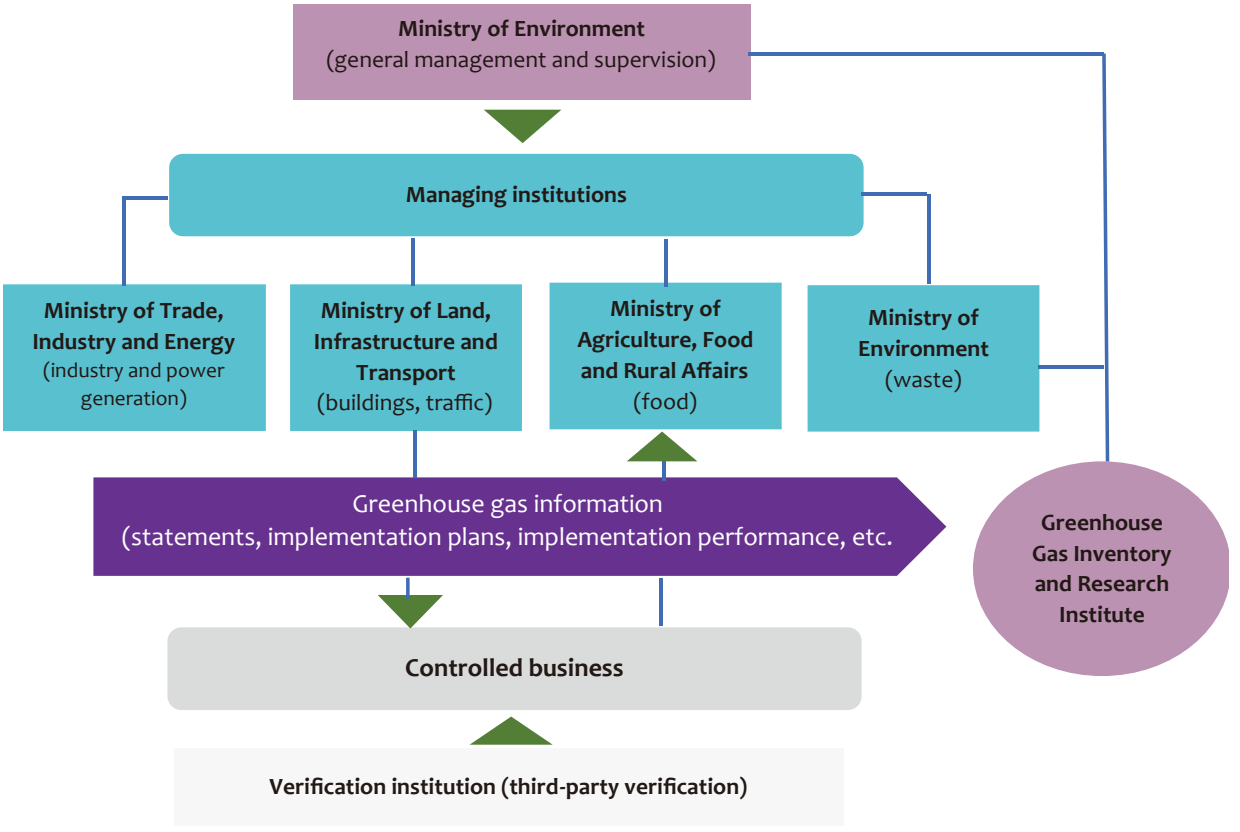
Energy

Energy Master Plan: In developing and implementing national energy policies and plans, the Energy Committee, established in 2006, elaborated the First Energy Master Plan for 2008-2030 in August 2008. Subsequently, the 5-year planning process of the Energy Master Plan was integrated into the National

Strategy for Low Carbon Green Growth (LCGG), pursuant to Article 40 of the Framework Act on Low carbon Green Growth (FALCGG) adopted in January 2010. The Energy Master Plan is a comprehensive plan that covers all energy sectors for 20 years of the planning period, and systematically links and coordinates energy-related sub-plans from a macro perspective (MOTIE, 2014). The Plan is amended every five years. The drafted initial plan and the amendment to the existing plan are presented to the Energy Committee under Article 9 of the Energy Act and then to the National Committee on Green Growth and the State Council consecutively for deliberation.

GHGs and Energy Target Management System: To cope with the global climate change and energy challenges, the central government has established and operated a system of GHGs and energy target management since 2009 based on the articles 42 of FALCGG on medium and long-term targets and the goals in greenhouse gases reduction, energy-saving and efficiency, self-sufficiency in energy, and supply of new and renewable energy.[17]

Figure 15. Operation of the Greenhouse Gas Target Management System



Source: Ministry of Environment, the Republic of Korea

[17] https://www.greencompany.or.kr:447/eng/introduce/system.aspx

As shown in Figure 15, the Ministry of Environment is in charge of the overarching framework of the GHG Target Management System, coordinating line ministries. The Ministry of Environment sets standards, drafts guidelines, and manages verifying agencies. Engaged ministries select entities to be subjected to the System per sector, sets targets based on negotiations and evaluate performance records. For that purpose, the government established the Greenhouse Gas Inventory and Research Institute (GIR) in 2010. The key function of GIR is to support the establishment of the national/sectoral GHG reduction target, to manage the national GHG inventory Measurement, Reporting and Verification (MRV) system and to operate the National Greenhouse Gas Management System (NGMS). GIR also supports the operation of the Greenhouse Gas and Energy Target Management System (TMS) and Emissions Trading System (ETS).

The Ministry of Environment designates business entities that emit greenhouse gas and consume energy in large volumes as controlled entities, imposes greenhouse gas emission and fossil energy consumption targets, and manages and supports them performance check. When a controlled business reports its previous emissions to the managing institution of each sector, the managing institution sets greenhouse gas emission goals for each industry, which then submit an implementation plan to achieve the goals. In the following year, the controlled business submits a statement specifying its emissions and energy consumption together with an implementation performance report after third-party verification. The statement and implementation performance are confirmed by the managing institution of each sector, then submitted to GIR. Correction notices and other such measures are used to address any business that fails to reach its goals or does not meet measurement, reporting, and verification (MRV) requirements (MOE).

Central administrative agencies, local governments, public institutions, other parts of the public sector are also subject to the greenhouse gas target management system in addition to industrial sectors. The aim is to encourage private sector participation to reach national greenhouse gas reduction goals based on public sector participation and leadership.

The target management system applies to 590 institutions as of 2019, including central administrative agencies, local governments, public institutions, regional public corporations, national and public universities, and national university hospitals. These institutions are required to carry out target management regarding the buildings and vehicles that they own or use.

The Ministry of Environment subsidizes the Green Rooftop Project to support greenhouse gas reduction activities by local governments. It also offers on-site reduction technology diagnosis and customized consultation to suit the circumstances of each institution by operating a “Public Greenhouse Gas Reduction Technical Support Team” (since 2012) to manage the reduction and provide greater support for vulnerable institutions. It is making a variety of efforts to encourage reduction activities in public institutions by organizing the “Public Sector Greenhouse Gas Target Management Performance Report Presentation” to award institutions that have been exceptionally successful in reduction activities, recognize exemplary cases, and gather suggestions (MOE, ROK).

Emission trading system: As a part of the national GHGs management system, the government also introduced an emission trading system providing a market-based GHGs reduction measure to accomplish the

national target of greenhouse gases reduction. The method of allocation of the allowable quantity of emission, the methods of registration and management, and the establishment and operation of an exchange for implementing the system are taken in charge by GIR. At present, the Korean ETS covers up to 70% of national GHG emissions, and the contribution of the national reduction target is expected to expand as the three-year target setting and implementation phase continues.

Industry

The government promotes green management practices by providing support and incentives aiming for the adoption of an environmentally friendly production system, which brings efficient use of energy and resources as well as reduced emission of greenhouse gases. (See Table 3 on the relevant authorities and sectors in the national GHG management system). Additional support from the government, especially in favour of small and medium-sized enterprises, was given to the research and development (R&D) and commercialization of green technologies; diffusion and utilization of ICT regarding energy saving and efficiency for GHGs reduction; accelerated mobilization of public and private financial resources for green investment in the form of the preferential tax system, interest rate, and subsidies. Provision of green technology and industry certificate and standard follows the support and incentive system. Other complementary low carbon development policy measures include the development of green technology and green Industry complexes as a part of balanced regional development programmes; policy measures promoting efficient mobility and conversion of human resources in the green industry sector.

Table 3. Competent/Relevant Authorities and Sectors in National GHG Management System

	Competent Authority	Relevant Authority	Sectors
Target Management Scheme (TMS)/Energy Management System (EMS)	Ministry of Environment (MOE)	Ministry of Trade, Industry and Energy (MTIE)	industry, power generation
		Ministry of Land Infrastructure and Transport (MLIT)	building, transportation
		Ministry of Agriculture, Food and Rural Affairs (MAFR)	agriculture, forestry, livestock, food
		MOE	waste, water supply
		Ministry of Maritime Affairs and Fishery (MMAF)	maritime, fisheries, shipping, ports

Source: NEASPEC secretariat based on Kang (2019)

Buildings

In the building sector, the government introduced a green building certification system based on the energy efficiency standard. It aims to improve and expand energy efficiency and renewable energy share in the building sector. The government sets and manages medium and long-term goal of energy efficiency standards and periodically reviews the goals against the standards prescribed by the Presidential Decree[18] to reduce the consumption of energy and the emission of greenhouse gases in buildings.

[18] https://elaw.klri.re.kr/eng_mobile/ganadaDetail.do?hseq=46773&type=abc&key=GREEN%20BUILDINGS%20CONSTRUCTION%20SUPPORT%20ACT&param=G

The green building system sets different measures and standards for each stage of the life cycle, i.e., building, designing, construction, maintenance, renovation and dismantling. These measures and standards contribute to the reduction of GHG emission from building sectors by enhancing the energy-efficient design standards and construction procedures which result in minimization of energy consumption and GHG emission in the entire building life cycle. For the buildings of central administrative agencies, local governments, public institutions, educational institutions, the government may ask the installation and management of intelligent meters for controlling and reducing consumption of energy such as power consumption, etc. in newly constructed or renovated buildings. The government expects a leading role of public sector in the transition toward green buildings.

Article 25 of the Energy Use Rationalization Act[19] assures the government to implement energy inspections on energy-saving programs of existing buildings to monitor and assess the performance in GHG reduction. Energy inspection contributes to the conversion of the existing stock of buildings toward green buildings. The government also endeavours to increase or supply green buildings through the new city development project as well as rehabilitation projects of the old urban centre as a part of smart energy-efficient urban planning policy. For that purpose, the Government may provide financial support, tax abatement or exemption, and other measures as prescribed by Presidential Decree.

Transport

The government sets and manages goals for the reduction of greenhouse gases in the transport sector to reduce GHG emissions and improve energy efficiency. The medium and long-term goals, phased and renewed periodically, cover the improved share of public urban traffic and railroad transport to establish low-carbon traffic systems, minimizing energy consumption and GHG emissions. The investment into railroads expands continuously to build the massive national infrastructure of main national transport networks. For urban traffic, the city governments expand the means of public transport, such as buses, subways, light rail transit systems, and encourage the use of bicycles and other low carbon personal mobile equipment.

On the supply side, the government takes a diverse range of policy measures, requiring automobile manufacturers to meet the GHG emission standards compatible with those of the international markets. For that purpose, the government introduced two standard systems: a standard for the average energy consumption efficiency and a standard for GHG emission allowance. The former standard aims to promote energy saving by improving the average energy consumption efficiency of automobiles. The latter standard is expected to improve atmospheric air quality by reducing exhaust gases and greenhouse gases from automobiles.

To avoid a double overlapping burden on the automobile industry, the government allows automakers and importers to choose one of the two standards. To reduce the burden of compliance with strict regulation, the government is providing financial support for early adapters in green cars, while imposing a charge for automobiles emitting more greenhouse gases. In addition, the government enhance the support schemes for research and development, manufacturing and distribution of low-carbon, high-efficiency transport means, such as hybrid vehicles and fuel cell electric vehicles.

[19] https://elaw.klri.re.kr/eng_service/lawView.do?hseq=5884&lang=ENG

The government also promotes an urban traffic demand management system to improve the GHG emission, air quality and social costs incurred by traffic congestion. To reduce traffic congestion in the Seoul Metropolitan Area, the local government introduces traffic congestion and inducement charges, BRT system, vehicle-free zones, low-pollution car incentives, and intelligent traffic information systems.

5. Challenges in low carbon city development

As highlighted in the comparative analysis and country studies above, the three countries in this study differ significantly in terms of the social, political, and economic backdrops against which low carbon city development is promoted. While many lessons can be shared, it is important to recognize these contextual differences when considering how the challenges and recommendations presented in this section may inform new policy efforts going forward.

Common Challenges in Low Carbon City Development

The three countries face many common challenges. This reinforces the growing awareness that cities around the world can learn from each other, which serves as the foundation for the proliferation of transnational city networks.

Target Setting

Identifying the appropriate level of ambition is a major challenge for cities pursuing low carbon development strategies. In China, the low carbon pilot cities are expected to support the fulfilment of the national target. In ROK, which also has a top-down approach to low carbon development, most cities have adopted the national target as their own. In Japan, meanwhile, the mitigation targets of cities are generally less ambitious than those of the national government.

As national governments need to raise their ambitions under the Paris Agreement, the practice and potential of low carbon development in cities needs to be well understood to in the “race-to-zero”. Cities face the challenge of not only building support for implementing existing plans or incremental improvements, but for far more ambitious plans that involve extensive reductions, and eventually transformations to zero carbon. No major cities have achieved such ambitious goals, so the challenge is amplified by the lack of clear models to follow. A small number of prominent international cities have made robust plans for carbon neutrality, including New York, London, and Paris, but all involve some long-term uncertainty regarding exactly how the goal will be achieved. In Northeast Asia, Jeju Special Self-Governing Province has a plan to become a ‘Carbon Free Island’ by 2030. Developing long term plans by 2020 that align with the Paris Agreement is a condition of C40 membership, which applies to cities in China, Japan, and ROK alike. Short-term goals may remain the immediate priority, but developing ambitious long-term goals remains a challenge for cities in Northeast Asia.

Support from National Governments

National governments can play a critical role in low carbon efforts at the local level. Although depending

on the degree of autonomy of the local government, support from a national government is not strictly necessary[20]. National governments shape the larger policy environment in which local governments operate. National governments can (i) provide policy coherence (particularly important in China where there are multiple pilot programs with overlapping mandates), (ii) help align national and local infrastructure and energy development plans, (iii) create market and financial regulations that affect investment decisions broadly, and (iv) provide funding and capacity building services for local efforts. National governments, of course, also provide leadership and serve as conduits of major international agreements and obligations (UNEP, 2018; OECD, 2014).

Since China's low carbon policy system is largely top-down, the recent institutional reform that relocated the Department of Climate Change from the NDRC, China's influential economic planning agency, to the MEE offers opportunities to synchronize efforts on decarbonization with broader agenda of "eco-civilization" in China for greater co-benefits. As described in the Japan-specific challenges section below, the formulation of local government plan is uneven. The prefectures that have the highest rates of energy consumption do not currently have the highest rate of plan formulation[21]. National level leadership could support local governments in developing low carbon plans and implementing them. In ROK, local governments are updating their local GHG reduction roadmaps in response to the 2018 revision of ROK's national mitigation roadmap, which aims for a 37% GHG reduction from BAU 2030. The national government could use this opportunity to apply lessons learned from municipal low carbon practices in the preceding years to these new plans.

Limited Capacity

Pursuing low carbon development involves new ideas, and often new resources. Harnessing these is a common challenge for cities that, except the largest and most wealthy, often lack capacity in terms of human, technical, and financial resources. In Japan, the national government's annual survey of local governments confirms this is the case. This study has found that more than 80% of local governments have indicated a lack of human resources as a challenge in formulating low carbon plans (see Japan section below). It also shows that a significant number of local governments, particularly for small urban authorities, lack a dedicated department for climate change issues (IGES, 2019). As discussed, cities in both Japan and ROK also generally have limited fiscal autonomy, making financial capacity a major challenge as low carbon strategies are often seen as an "additional" effort that must compete against existing priorities. Even in China, where cities have much greater fiscal autonomy, Wang et al. (2015) highlight that expertise and technical capacity regarding low carbon development strategies and policies are severely lacking, even in relatively large and wealthy Low Carbon City Pilots (LCCPs). Such capacity challenges are the reason why networks such as C40 dedicate significant resources toward technical support.[22]

Political and Economic Uncertainty

Lower economic activity could lead to lower carbon emissions, in particular in countries with economic activities closely related to carbon emission growth. However, economic downturns can also lead to a waning of support for environmental protection and emissions reductions. In this scenario, cities may find

[20] For example, in the United States, local governments, state and municipal, have the authority to pursue ambitious carbon reduction goals and join transnational city networks.
[21] See Figure 18 in the next section on country-specific challenges.
[22] C40, for example, employs "city advisors" to be embedded in and work directly with the staff and officials of member cities.

it especially challenging to advance a low carbon agenda and more work will be required to build broad-based support for costly carbon reduction initiatives. In the case of China, which faces the twin challenge of a protracted economic slowdown and continued urbanization, recessions in export markets could cause the relaxation of low carbon policy, including support for low carbon actions at the city level, in favor of economic stimulus, including the deeper entrenchment of fossil fuels for primary energy, motivated by an energy security imperative (iGDP, 2019). The on-going trade tensions between China and the USA also have global ramifications that will affect trade in green technologies.

Data Collection, Consistency, and International Coordination

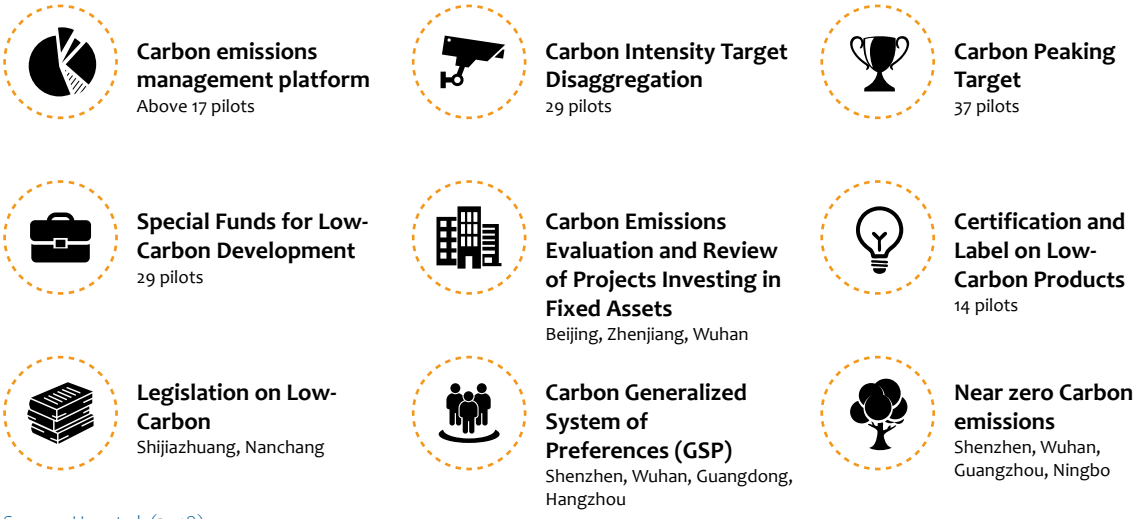
Ensuring proper data collection is a common barrier for cities' low carbon development efforts as it is difficult to reduce carbon emissions without knowing their sources and impossible to measure progress without robust monitoring systems. At the same time, tracking of emissions and other data at the city level tend to lag far behind that at the national level. China has recognized this and has made the development of GHG inventories and green indicators a priority for its LCCPs. Likewise, Japan's support for cities in developing their local climate plans contains a significant data component. ROK's FALCGG recommends the development of local GHG inventories though it is not a requirement. Except some larger cities, most have not done so, a trend that is mirrored in both Japan and China. The lack of consistent, reliable data on emissions and other dimensions of low carbon development in cities also frustrates research efforts that could support cities in their policy efforts. The 2018 Emissions Gap Report notes that lack of data transparency and common reporting standards are hampering efforts to coordinate actions at the national and subnational levels (UN, 2018).

Country-specific Challenges

China

Low carbon cities entered China's climate policy agenda in 2009 when NDRC launched the low carbon pilot program. Over the past ten years, these low carbon pilots have developed carbon management platforms, target disaggregation systems, special low carbon funds, low carbon labelling programs, and other tools and mechanisms to drive down emissions. These advancements provide a basis for the further integration of low carbon city policy into China's overall low carbon development policy framework. They also constitute a knowledge source of effective practices that can be shared with other cities in China or with other countries pursuing sustainable and low-emission economic development (Figure 16).

Figure 16. Summary of accomplishments in China's low carbon pilots



Source: Hu, et al. (2018)

These early accomplishments notwithstanding, China's low carbon pilot cities, low carbon pilot program, and other efforts to achieve sustainable urban development will likely need to overcome a series of challenges in the years ahead.

Sustaining momentum after institutional reforms

Ministry of Ecology and Environment (MEE)'s low carbon pilot program requires sustained, long-term guidance and support. The transfer of the low carbon pilots program to MEE resulted that climate change along with other environmental policy are now governed by the same ministry. In the long term, this may lead to improvements in the urban carbon emission measurement, reporting, and verification (MRV) system, bringing it up to par with China's rapidly improving MRV systems for other pollutants. In the near term, however, the administrators of China's low carbon pilot program face the challenge to navigate the transition of authority and personnel and fitting a complex program into a new ministry that will be looking to find a foothold in China's complex institutional landscape.

Competing policy priorities at the local level and unstable local leadership

The policy priority for China's local governments remains economic development. This focus on economic performance is reinforced by a government personnel management system in China that, despite recent reforms, remains biased toward good performance against economic indicators. Moreover, China's government personnel management system involves regular transfers and rotations (including the mayor of cities), creating the potential for loss of leadership, momentum, and policy expertise in low carbon initiatives (Hart, et al. 2018).

International experience shows that commitment by city mayors and other leaders is crucial because low-carbon development involves nearly all city operations. Cities' low-carbon development and sustainability efforts must be integrated with regular city planning efforts to be effective. In addition, a strong administrative team is needed, including managers, dedicated staff, community support groups (with

active public participation), and knowledge partners (universities and research institutes). In most cities, local government officials regard economic growth as their major priority, which affects their personal careers. Low-carbon development is treated as the lower priority unless it can promote economic growth (Council of Scientific Research on China's City, 2009; Qi, 2014). Without strong support from the mayor, ministries such as the NDRC and the Ministry of Industry and Information Technology (MIIT) find it difficult to coordinate their operations or share information.

Uncertainty surrounding China's future economic growth rate

China has entered a new economic normal in which the economic growth rate of many cities has slowed down. For many Chinese low carbon pilot cities, industrial restructuring or improvements in industrial energy efficiency are key means of lowering emissions (Oshita, et al. 2015). Moving away from energy-intensive industry is contingent on the existence of alternative sources of economic growth and employment. China's general economic slowdown may tempt pilot administrators to relax these critical industry-focused emissions reduction efforts.

Improving Monitoring, Reporting and Verification

China's low carbon pilot cities do not currently belong to a universal or integrated system to gather or publish city-level GHG data. These systems, when they are developed, will need to be able to capture changes in emission trends driven by China's ongoing rapid urbanization and economic transformation, and will also have to be consistent with international methodologies so that Chinese climate policymakers can speak the same language with their international counterparts. Strong systems for monitoring emissions are also often missing (Hart, et al. 2018).

Making low carbon cities "smart" by assimilating emerging technologies

New digital tools and technologies, such as mobile payment, artificial intelligence, and big data, are quickly reshaping the business landscape, consumption patterns, and overall lifestyles in China's cities. Low carbon pilot administrators, who are already hobbled by a lack of technical capacity, will need to raise their technological literacy to take advantage of the potential new efficiencies afforded by these new tools and technologies. "Smart Cities" are now an active area of policy and research in China. The Ministry of Housing and Urban-Rural Development (MOHURD) has managed a national smart cities pilot project since 2013 (Yuanping, et al. 2019). Finding synergies between China's smart cities and low carbon pilot programs will require capacity building, coordination between policymakers working in different ministries, and consultations with experts in new technologies from academia and the private sector.

Japan

Since the enactment of the Global Warming Act in 1998, the Japanese government has been promoting the establishment of systems to encourage industries, local governments and the public to work together to reduce GHG emissions. In particular, local governments are being requested to formulate and implement action plans and urged to carry out policy planning that can simultaneously solve socio-economic issues in the region and reduce GHG emissions. Support measures are needed, as mentioned above. Although GHG emissions have been decreasing since 2013, this decline is not significant enough to reach the target of a 26% reduction by 2030.

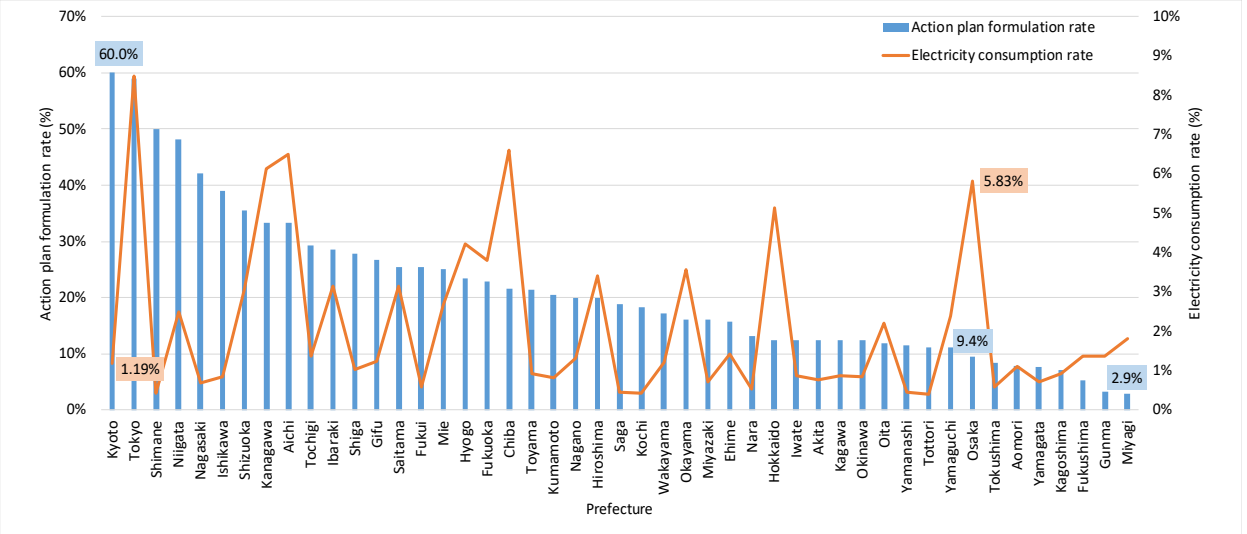
Although local governments are the drivers in creating low-carbon cities, the following issues have been identified, drawn from the results of surveys by the Ministry of the Environment on the state of local government action plans.

Disparities in the introduction rate of action plans in the region

There are wide variations across the prefectures in formulating action plans at the sub-prefectural level, although the number of the local governments in each prefecture also varies. Figure 17 compares the share of local governments which formulated action plans in each prefecture (excluding prefecture governments and prefectural capital cities) and each prefecture's share of national energy consumption. For example, in Miyagi Prefecture, only 2.9% of the local governments formulated action plan, compared to 60% in Kyoto Prefecture.

In addition, a comparison of the formulation of action plans with the share of energy consumption in each prefecture indicates that there is no clear link between the two. In other words, even though the local energy consumption rate in Kyoto Prefecture is only 1.19%, the formulation rate for its area-wide plan is 60%, while Osaka Prefecture has a formulation rate of only 9.4%, although its local energy consumption rate at 5.83% is above the national average. While it is preferable that the formulation ratio for area-wide plans is higher in areas with higher energy consumption rates, the current trend does not show any correlation between these two aspects.

Figure 17. Action plan formulation rates and electricity consumption rates by prefecture, 2018



Source: Ministry of the Environment, Japan. "Survey on the state of legal enforcement of the promotion of global warming countermeasures by local governments: Report on study results (Revised version)", September 2018 (Action plan formulation rates); Agency for Natural Resources and Energy (Electricity consumption rates).

Lack of dedicated departments / human resources in the local governments

By law, local governments in Japan are required to formulate action plans. However, depending on the population size of the more than 1,700 municipalities and their level of socio-economic development, their capability to develop plans and the challenges they face also differ. Each year, the Japanese government conducts a questionnaire survey of all local governments to review the status of formulating plans and the issues they face. According to the latest survey, more than 80% of local governments have indicated a lack of human resources as a challenge in formulating action plans. It is also reflected in the survey results that the smaller the population, the more likely their local governments have no departments in charge of climate change policy (Table 4).

The absence or limited capacity of the dedicated department for the climate change policy is likely reflected in the other challenges identified in the survey, such as lack of expert knowledge and difficulty evaluating the effects of policies and measures.

Table 4. Number of local governments with departments in charge of climate change policy

Type	Number of populations	Department in charge of climate change policy		
		Have	None	
Prefectures		47	0	
Ordinance-designated cities		20	0	
Core Cities		48	0	
Special case cities		36	0	
Cities, towns and villages	100,000 or more	180	3	1.70%
	30,000-99,999	481	19	4.00%
	10,000-2,9999	422	26	6.20%
	10,000 or less	415	91	21.90%

Source: Ministry of the Environment. "Survey on the state of legal enforcement of the promotion of global warming countermeasures by local governments: Report on study results (Revised version)", September 2018.

Constraints of financial resources and measures at local level

The reduction targets of local governments cannot be achieved without financial measures. However, it is difficult to obtain the support of local councils/assemblies solely based on the target of reducing CO_2 emissions. While it is important for the national government to increase support to local governments, more critical importance is to simultaneously address GHG emission reductions with solutions for local issues and be able to involve stakeholders and entities that implement programs so that they can obtain funding from support offered by the national government. The cities presented in the case studies (Section 7) showcase such innovative examples. However, such initiatives tend to be hampered, especially in smaller municipalities, both in terms of human resources and a lack of expertise. For such small local governments, it will be necessary to identify and provide examples of actions that can be promoted using systems to involve external experts, if necessary, in cooperation with local residents.

Republic of Korea

Following the 2018 revision of the national mitigation roadmap of the Republic of Korea, which outlines the measures that will be taken to NDC 2030 targeting 37% GHG cut down from BAU 2030, cities are revising existing local GHG reduction roadmaps.

The mitigation from local climate action was estimated approximately about 25.7% of national business usual GHG emission level in 2020 (776.1 million ton of CO_2 equivalent). The government planned that 499 million ton (64.3% of national emission) could go under the control of the national carbon management system (NCMS) composed of energy and GHG target management and GHG emission trading for heavy emitters in industry and other sectors except for households. Emission outside of national control (EONC) was about 35.7% of national emission and that part was concentrated on households, transport and commercial and public sectors. It was estimated that about 72% of EONC falls on the local government's mitigation actions.

Conformity of local GHG inventories to the national GHG monitoring system

Achieving the national target of GHG mitigation requires a coordinated monitoring, reporting and verification system between central and local governments. For that purpose, the Ministry of Environment supports the development of local GHG inventory system and annual statistical report of local GHG emission on a voluntary basis. In the beginning, the central government proposed to use the national GHG inventory guidelines following the IPCC guidelines. Since 2006, the government has promoted a local GHG inventory system based on locally adapted indicators. The local GHG inventory guidelines are provided by the Korea Environment Cooperation with the mandate of the Ministry of Environment.

This change results in substantial challenges in the implementation of the national mitigation target in collaboration with local authorities. At the moment, the national GHG emission outside of the central government control is not well attributed to each local authority's administrative territory. The top-down allocation of the national GHG emissions does not correspond to the bottom-up compilation of local GHG inventories in some cases. This may come from the fact that local GHG inventory guidelines adapted from the national one do not necessarily provide sufficient details more appropriate to the local context of GHG emission with different socio-economic drivers. In addition, the central-local coordination in GHG emission control is greatly challenged by the fact that current local GHG inventories do not cover all the local administrative units from province to city and county as well as from metropolitan cities to district.

Limit in local fiscality financing climate actions

The challenges faced by each local government are different depending on the level of fiscal autonomy of the local budget and policy priority in light of the socio-economic context of regional development. Above all, the budget matching principle requires a mobilization of local budget resources matching the central government transfer to finance the implementation of major program and projects in the local climate action plan. Without the substantial engagement of local authorities, cities in climate action could not meet the local priority of climate actions which may fall outside of national priority. This calls for innovations in green financing mechanisms, including market incentives for PPP in line with the national low carbon development policy framework.

Voluntary aspect of GHG inventory and mitigation roadmap development

The development of local GHG inventory and mitigation roadmap is not mandatory in legal terms. Nevertheless, local adaptation planning is required by the law. The central government also encourages and supports local governments' implementation of local low carbon green growth strategy. At the sub-national level, each local government, taking into account the local geo-economic and social characteristics, formulates and execute the Low Carbon Green Growth (LCGG) plans and projects within its jurisdiction and takes necessary measures for encouraging activities of business entities, residents, and non-governmental organizations. The ROK should consider whether to make mitigation roadmaps mandatory and offer support for this effort.

Continuous support from local institutes specialized in climate change policy

Climate action at the local level is mostly taken up by the public authorities that are not necessarily well equipped with rigorous expertise in science and evidence-based policy development and implementation. Moreover, climate policy covers a wide range of sectoral urban policies which requires elaborated coordination among different departments in charge of buildings, transport, waste management as well as a transformation of the local energy system toward low carbon clean energy sources.

As in the case of Gwangju Metropolitan city, some cities are supported by specialized climate change expert group working on local climate change policy. But most district and county level authorities do not have such technical support assuring a stable implementation condition of locally appropriate climate actions. The central and higher level of local governments need to enhance the local policy support infrastructure by enhancing institutionalization of local expertise linked to the national climate change think tank already in place at the central government level.

*Outreaching efforts for global sharing of local experience*s

Disseminating good practices will also be a challenge. With Gwangju's 'Agreement on the Climate Change Model City' with the Ministry of Environment in 2008, the city now promotes its inventory and carbon management tools as a member of the nation's Urban Environment Accords, for which it serves as the secretariat. ROK should challenge itself to ensure that these tools find widespread use. The city of Suwon is actively involved in international cooperation by registering and sharing their actions for climate change response, GHG inventory, and reduction targets by uploading them to ICLEI's Carbonn Cities Climate Registry (cCR) and CDP (Carbon Disclosure Project). Encouraging other cities to follow suit will also be a challenge.

6. Conclusion

Promoting low carbon city development is urgent but challenging. This report has provided an analysis of the structure and status of low carbon city policy and action in China, Japan, and the ROK. It has outlined the key challenges each country is facing as it pushes these efforts forward. While the national circumstances in each country vary, there are some common ways forward. This section offers some general recommendations in that respect.

Recommendations

Link to Co-benefits

Gathering support for low carbon city policy is challenging but critical:
Effective, ambitious low carbon city policy will lead to significant changes to how cities are built and how people travel, consume, and manage their waste within them. Implementing such policies, whether at the national or subnational level, will therefore require building broad coalitions of support among all stakeholders. Gathering support for administratively complex and financially burdensome carbon reduction policies can be challenging when purely focusing on GHG emissions. The threat of climate change often appears distant and the size of the emissions reductions from any one city may seem insignificant compared to the scale of the challenge.

Co-benefits of GHG emission reduction may gather more support:
One way to overcome this is by drawing explicit links between low carbon city policies and benefits beyond GHG mitigation. A policy or action that also delivers the co-benefit of reducing traffic or energy consumption, or improving air quality or urban livability, is more likely to receive widespread support than one that only reduces GHG emissions. The co-benefits of low carbon development are many and rest on a robust body of evidence. For example, investments in low carbon public transport reduce GHG emissions from cars but also improve economic productivity through reduced congestion, reduce air pollution, and often reduce health costs through fewer accidents (Kwan & Hashim, 2016). Raising the sustainability standards of buildings not only reduces their GHG emissions but lowers energy bills and improves indoor comfort and productivity (WGBC, n.d.).

Possibly connecting with a wider range of funding sources:
Emphasizing the co-benefits of low carbon policies can also help cities overcome financial and capacity constraints by connecting to a broader range of funding sources. For example, there may be funding streams available for health or air quality rather than emissions reductions; a co-benefits approach can effectively integrate these and make such funding relevant and accessible.

Cities can also embrace low carbon development in their urban policies:
Co-benefits, moreover, can be pursued in a two-way fashion. Low carbon city administrators can support environmental and urban livability policies for their direct benefits and assimilate their indirect carbon reduction effects into low carbon plans and assessments.

Improve Data Collection and Create Common Metrics

The ability to track, analyze, and support the enhancement of low carbon city policies and actions is dependent on the quality and availability of relevant data. This report has made some initial, broad comparisons of low carbon city development in China, Japan, and the ROK, but the depth of analysis is restricted by the amount of accessible data. Most importantly, the lack of time-series data on city-level GHG emissions makes measuring or comparing the effectiveness of low carbon city policies and actions

exceedingly difficult. Similar issues exist regarding tracking non-state and subnational climate action and low carbon development efforts in all regions of the world (UNEP, 2018).

Consistent measurement methodologies:
Being able to track the impacts of low carbon city policy is crucial to ensuring their effective implementation and sharing the benefits of such policy to encourage action on a wider scale. Converging on consistent methodologies is an important step for quantifying subnational and non-state climate action (Hsu et al. (2019). This is echoed by UNEP's 2018 Emissions Gap report, which called for common principles to be adopted for measuring subnational climate action that "include clear and quantifiable targets based on relevant benchmarks, technical capacity of the actors, availability of financial incentives and the presence of regulatory support" (UNEP, 2018). National governments should look to encourage such alignments domestically, while regional organizations should do so transnationally.

Financial support essential for the long-term benefits:
Technical capacity and financial support will need to be increased to produce more consistent and higher quality data, but the benefits of doing so would be significant. It would allow best practices to be identified and shared in a more rigorous, outcomes-orientated manner; create a stronger baseline for implementation and enforcement; and facilitate deeper research into the institutional, social, and economic factors shaping low carbon city development, such as those mentioned in this report.

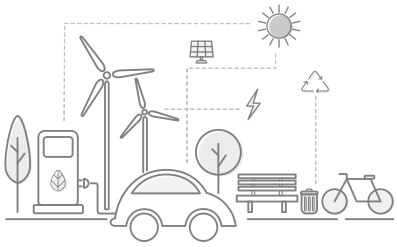
Strengthen Regional Networks of Support with Targeted Policy Advice

This report shows that cities in the three North-East Asia countries of China, Japan and the Republic of Korea have each amassed a great deal of experience in low carbon city policy at both national and subnational levels. Policymakers and policy experts at the national and municipal levels of these countries are also active in various international collaborative projects and networks. Currently missing, however, are mechanisms or institutions for the countries of North-East Asia to offer support to each other at a scale that is proportional to the climate challenge. The North-East Asia Low Carbon City Platform established under the North-East Asian Subregional Programme for Environmental Cooperation (NEASPEC) is a step in this direction. ICLEI East Asia provides excellent technical and capacity building services to its network participants but operates on a membership model and has a mission that includes but goes beyond low carbon city policy.

To draw maximal value from the national, sectoral and municipal good practices in low carbon city policy from this region, future projects should address the development of tools, mechanisms, or platforms that facilitate the transmission of know-how across national boundaries.

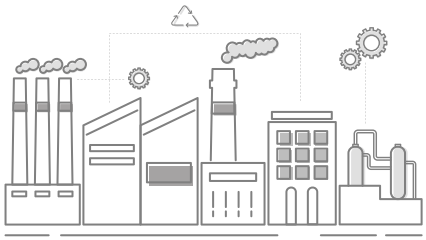
This know-how should also be channelled in the right direction and should address the specific challenges of the country or local government receiving support. China, Japan and the ROK have diverse emission driver profiles, levels of economic development, and institutional structures and policy frameworks, and this diversity is greater at the municipal level. These differences make it a challenge to identify the specific features of national, subnational or sectoral low carbon city policy that are genuinely relevant in other

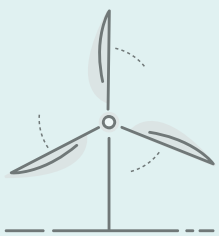
contexts. Japan and Korea's responses to the emissions effects of ageing populations may be instructive for China, which is expected to experience a similar demographic transition in the coming decades. China's efforts to introduce low carbon practices in a period of rapid economic development and urbanization could prove useful to other countries in North-East Asia looking for ways to strike a balance between economic and environmental policy priorities. Moving beyond North-East Asia, cases of successful carbon reduction efforts under conditions of rapid economic growth in China could also be transferred to developing economies under the Belt and Road initiative. But these observations are of superficial characteristics. Matching the demand for targeted policy advice with the appropriate expertise or lessons learned will require deep dives into local conditions. As this report shows, low carbon city policy is not one-size-fits-all.



PART II

Case Study





7. Good Practices

Overview

This section takes a close look at good practices in low carbon city policy at the local and project level in fifteen brief case studies. The case studies highlight three aspects of good practice: effectiveness and efficiency, sustainability and transferability (the relevance of the policy or practice to other cities). The case studies also illustrate the use or appearance of the local low carbon policy approaches and features described in the preceding section of this report: level of ambition and leadership, the promotion of voluntary participation in low carbon city programs or campaigns, the provision of market-economic incentives for carbon-reducing activity, and the use of the command-and-control tools under the legal authority of local governments. The table below categorizes the fifteen case studies against these four analytic dimensions, although these dimensions are not mutually exclusive.

Table 5. Case studies by Local-level Low Carbon City Policies and Approaches

	Ambition and Leadership	Command-and-control Tools	Voluntary Tools and Stakeholder Engagement	Market-economic Tools
China	1. Zhenjiang Carbon Emission Management Cloud Platform (pioneer) 3. Large-scale Existing Public Buildings Renovation in Changning District, Shanghai (local government leadership)	4. Turpan New Energy Demonstration Zone – (new energy demonstration site) 5. Guangzhou Bus Rapid Transit	2. Qinhuangdao Energy Efficiency Building Projects (stakeholder engagement)	6. Shenzhen ETS Pilot Program
Japan	2. Power systems: Miyama Smart Community (provides a model for other cities)	3. Transport: Toyama Compact City 5. Kitakyushu Eco-town – Waste Management	1. Smart community: Yokohama Smart City Project (YSCP) (local stakeholder engagement)	4. Tokyo Cap & Trade
Republic of Korea	2. Jeju Province - from World Environmental Hub to Carbon Free Island (global ambition)	1. Gwangju Metropolitan City - Urban Carbon Management System (official city-wide effort)	3. Suwon City - Transport (community-based public participation)	4. Gwangju Metropolitan City - Financial Incentives for Low Carbon Lifestyle

Ambition and Leadership

In China, Japan, and the Republic of Korea, municipal policymakers often have the authority and drive to exceed the ambitions of national governments. In China, low carbon pilot cities are expected to lead the fulfilment of national mitigation or energy-related targets. Chinese cities in the national low carbon pilot

program are also encouraged to show leadership and serve as exemplars of effective or innovative practices. The Carbon Emission Management Cloud Platform developed in the city of Zhenjiang is an example of leadership in local-level emissions management in China. Being one of China's earliest efforts at robust CO_2 emissions management, it has pioneered the application of cloud computing, geographic information systems, and AI, as well as visualizations of carbon emissions data. However, in Japan, the mitigation targets of cities are generally less ambitious than those of the national government, which is reflective of the country's comparatively bottom-up political system in combination with limited city capacity. In the Republic of Korea, with a top-down approach to low carbon development, most cities managed to adopt a local mitigation target corresponding to the national target due to the limited local fiscal resources.

Selected cities in both Japan and the Republic of Korea have undertaken ambitious projects to refashion large parts of their energy and industrial sectors, or transport infrastructure, in a conscious effort to become champions of progressive energy and climate policy. In Japan, Miyama Smart Community in Japan has developed a system to produce and sell renewable energy with its revenues cycled back into social support services that counteract depopulation, the outflow of younger generations to other areas, and the shrinking of the local economy. Miyama offers an innovative model for other communities that are looking for ways to address climate change and local social challenges at the same time. In the Republic of Korea, Jeju Province has embarked on a multi-year, province-wide effort to transform itself into a global hub for environmental protection and a carbon-free island. The province aims to become a global paragon of livability, where environmental protection, economic vitality, and personal well-being are in harmony.

Command-and-control Tools

In Chinese cities, where local authorities have strong fiscal capacities and relatively top-heavy decision-making processes, low carbon development is often driven by command-and-control approaches. The Turpan New Energy Demonstration Zone and Guangzhou Bus Rapid Transit case studies illustrate that local municipal authorities use their wide-ranging powers to reshape major features of the local urban landscape.

Command-and-control measures are also used in Japan and the Republic of Korea in developing ambitious, large scale carbon-reduction schemes, as noted above. In Japan, the Toyama Compact City and Kitakyushu Eco-town case studies are examples of comparable large-scale transformations efforts by local governments to reshape their cities.

In the Republic of Korea, the development of the ICT based Urban Carbon Management System in Gwangju is a city-wide effort focusing on enhanced science-policy interface. The city of Gwangju signed the first agreement with the Ministry of Environment to undertake ambitious climate actions. Gwangju currently has 74 project-level low carbon initiatives across four sectors, including the development of city-level micro climate-change impact assessment tools.

Voluntary Tools and Stakeholder Engagement

Cities in Japan and the Republic of Korea rely significantly on voluntary approaches due to their limited fiscal and regulatory authority, as well as their relatively pronounced bottom-up government structures. In Japan, local governments engage heavily with industry as they develop low carbon policy to support and

encourage voluntary emission reduction efforts across sectors. The Yokohama Smart City Project provides a good example of strong stakeholder engagement and the encouragement of voluntary participation and support for ambitious carbon reduction schemes. Its goal is to take the lead in establishing the world's best smart city model. Thus, the city established the Yokohama Smart Business Association, a new public-private collaborative council. It ensures the cooperation of companies and demonstrates to the private sector that taking local action will lead to business opportunities both in Japan and overseas.

This sort of stakeholder engagement is also evident in the case study of the city of Suwon in the Republic of Korea. Suwon, which aims to become the 'Environment Capital of the Republic of Korea', has invited community-based public participation in support of evidence-based climate policy and measures. It launched a special committee on climate change and organized a series of town hall meetings to review different GHG reduction scenarios by 2030. The outcomes of these meetings and public consultations resulted in a 2030 GHG reduction target that is 40% lower than the emission level in 2005. In China, the success of the Energy Efficiency Building Project in Qinhuangdao also depended on stakeholder engagement. A key success factor of the project was the inclusion of central and local authorities, science and technology supporting agencies, real estate developers, and constructive cooperation between Chinese and German technical experts.

Market-economic Tools

Perhaps the most prominent market-based instrument is the development of emissions trading systems (ETS). While they are most commonly created at the national level, both Tokyo and Chinese LCCPs have developed them at the municipal level. Tokyo's ETS is the world's first urban cap and trade system for the industrial and business sectors, whose CO_2 emissions account for about half of the metropolitan area's emissions. Although Shenzhen only accounts for a small proportion of total carbon emissions in China, the local ETS achieved emission reduction far exceeding the 21% reduction target set by the central government for Shenzhen during the Twelfth Five-Year Plan period. The local ETS managers now serve a leading advisory role in the development of the national carbon market. In the Republic of Korea, the city of Gwangju collaborated with the Ministry of Environment to launch the Carbon Bank Program, which provides subscribers with carbon points to promote a low carbon lifestyle in the consumption of energy and water services.

Sectoral Relevance

To highlight the sectoral aspects of the case studies, Table 5 is re-arranged by country and sector in Table 6.

Table 6. Case Studies by Country and Sector

	China	Japan	Republic of Korea
Market mechanisms	Shenzhen Emissions Trading Pilot	Tokyo Cap & Trade	
Buildings	(1) Qinhuangdao Energy Efficient Buildings (2) Shanghai retrofitting buildings for energy efficiency		
Power systems	Turpan Solar Energy	Miyama Smart Community	Jeju Province Carbon Free Power System
Transport	Guangzhou Bus Rapid Transit	Toyama Compact City	Suwon City - Transport
Carbon Management	Zhenjiang Management System Innovation		Gwangju Metropolitan City Urban Carbon Management System
Smart Communities		Yokohama Smart City Project	
Waste Management		Kitakyushu Eco-town	
Public Participation			Gwangju Metropolitan City Financial Incentives for Low Carbon Lifestyle

China

This section selects cases that reflect local low carbon development experiences in different sectors, different regions, and at different scales. In terms of city type, they cover practices implemented by megacities, mid-sized cities, and districts and communities. In terms of low carbon actions, they cover low carbon management systems, key policies, and sector-specific actions in energy, buildings and urban transport (Figure 18).

Figure 18. Chinese Best Practice Case Studies

Source: iGDP (2019)

Management System Innovation: Zhenjiang Carbon Emission Management Cloud Platform

Developing city's GHG statistics accounting system, a monitoring and evaluation system, and capacity building mechanism have been critical challenges faced by China's cities at the initial stage of developing a low carbon pilot. The Zhenjiang city took the lead in this area. In 2013, it launched a carbon emission accounting and management system platform that integrates data collection, accounting, and management systems (Figure 19). This Platform is the core and foundation of Zhenjiang's urban carbon management system. It provides a visual display of carbon emissions data on a user-friendly map. The scope of data collection includes economy-wide total carbon emissions, carbon emissions from industrial processes, carbon emissions from energy sources, carbon emissions from waste, and carbon sinks. Intelligent carbon emission data collection and analysis systems provide data for pilot administrators to make low carbon development decisions.

Figure 19. Zhenjiang Low Carbon City Management Cloud Platform

Effectiveness and Efficiency

This system was developed as an early entrant in the field of CO_2 emissions management, using new information and internet technologies such as cloud computing, geographic information systems, and AI. It is now recognized as a pioneer in China in the promotion of scientific, digitized, and visualized carbon emission data management.

The system consolidates GHG emissions data from various urban management agencies and multiple sectors, including land use, environmental protection, resource management, industry, energy conservation, emission reduction, and carbon reduction, among others. In terms of management levels, it covers city-level, district (county) level, industry level, enterprise-level, and project-level data. In terms of time span, the system includes historical data, current data and future projections. The Carbon Emission Management Cloud Platform is based on real-time data collection of energy consumption and industrial production processes related to carbon emissions, and 48 key enterprises with annual greenhouse gas emissions of more than 25,000 tons of CO_2eq are included in the platform. The emissions from these enterprises account for 66% of the city's total emissions

Through three systems of collection, aggregation, accounting and management, the platform can visually display the city's carbon emissions and provide scientific support for status assessment, trajectory forecasting, reduction potential analysis, target setting and performance tracking.

Sustainability

The local government has provided funding and institutional support to establish and maintain the platform's construction and operation and established a leading group on low carbon city construction led

by the city mayor. This group is responsible for coordinating the development of low carbon work in various fields, coordinating and solving major problems encountered in the construction of low carbon cities, and carrying out the monitor and evaluation of the situation of low carbon cities construction. The Zhenjiang Carbon Emission Management Cloud Platform is the key tool used by the group to implement improved management and scientific decision making for carbon emissions control.

Transferability

Following Zhenjiang case, other low carbon pilot cities in China have also established on-line carbon management platforms, including Wuhan, Shenzhen and Lanzhou. The Zhenjiang Carbon Emission Management Cloud Platform has established a benchmark for low carbon pilot cities across the nation by using information technology to improve low carbon management.

Ultra-Low Energy Consumption Buildings: Qinhuangdao's Energy Efficiency Building Projects

At present, China's passive low-energy consumption buildings are still in the demonstration stage. Compared with developed countries, China still has a large gap in this field. It largely lacks comprehensive standards and policy system, low professional capacity, and mechanisms to incentivize and absorb technological innovations.

Qinhuangdao is in Hebei Province, northeastern China, facing Bohai Bay. It has a warm to temperate semi-humid monsoon climate, with annual temperature variation between -9 °C and 29 °C. The population of Qinhuangdao is about 3.11 million, with a per capita GDP of 48,539 yuan.

Nine demonstration buildings (with a total area of 80,344 m^2) are located in Zone C of Qinhuangdao's "Zai Shui Yi Fang" residential area. These buildings are the first China-Germany passive building and ultra-low energy building demonstration projects. Building C15 completed in October 2013 (6,467 square meters of building area) became the first ultra-low energy consumption building in China, as determined by the German Energy Agency.

Effectiveness and Efficiency

The pilot is designed to deliver a comfortable indoor environment at an acceptable cost. The building can keep a room temperature of 22-25 degrees Celsius throughout the year and have a comfortable level of indoor humidity of 40%-60%, with a low carbon dioxide concentration of less than 1000ppm. Compared with buildings conforming to local building codes, the additional construction and installation costs for Building C15 amounted to 577 yuan/m^2 (including heat recovery system with new wind health function, external thermal insulation thickening system, improved door and window quality). However, C15 ultra-low energy building reduced the cost of heating and cooling, as well as the demand for connections to traditional central heating systems in urban areas.

Table 7. Cost Comparison of ultra-low energy buildings and buildings conforming to 75% local building codes

	C15 ultra-low energy building	75% energy-efficient building	Additional cost
1 Construction and installation cost			
1.1 Construction and installation cost (yuan/m^2)	2451	1749.9	701.1
1.2 Cost for Connecting to district heating pipe network (yuan/m^2)	0	124	-124
Total (yuan /m^2)	2451	1873.9	577.1
2 Maintaining and operating cost	Saving cost of C15 building ultra-low energy building, compared to ordinary residential building		Note: Heating costs for ultra-low energy building: 0.52 yuan / kWh; Central district heating costs: 0.24 yuan / m^2 / day Ordinary residential cooling hours: 5h / day
Saving heating cost (yuan/m^2/day)	0.02-0.01		
Saving cooling cost (yuan/m^2/day)	0.02-0.04		

Sustainability

The key element in the success of Qinhuangdao' ultra-low energy consumption buildings has been stakeholder engagement, including central and local authorities, science and technology supporting agencies, the real estate developer and cooperation relationship between Chinese and German experts.

Transferability

Qinghuagndao's "Zai Shui Yi Fang" ultra-low-energy consumption building project has served its intended demonstration effect. The level of high-energy efficiency of the new buildings and the method for constructing them in Hebei Province has led to the improvement of energy efficiency standards in Hebei Province as a whole. In May 2017, Hebei Province issued a new regulation for new residential buildings to fully implement 75% of local building codes and to have all commercial and residential buildings fully implement the green building standards. The demonstration project also introduced the "Energy Efficiency Building Code for Passive and Ultra-Low Energy Consumption Residential Buildings" to Hebei Province. This is the first building code for passive and ultra-low energy consumption building standard in China, providing a reference for similar standards in other climate zones.

Qianghuangdao's ultra-low energy consumption building demonstration has proved that it is feasible to promote passive and ultra-low energy consumption buildings under China's existing conditions. It shows that ultra-low energy consumption buildings can improve indoor living environments while significantly reducing energy consumption using affordable technology.

Large-scale Existing Public Buildings Renovation in Changning District, Shanghai

China has more floor space than North America and Western Europe combined. Most of these structures are energy-inefficient, offering tremendous potential for carbon reductions. Districts where large-scale public buildings are highly concentrated lack baselines for building renovation, binding controls, as well as incentives for energy efficiency upgrades.

In May 2010, the Shanghai Municipal Development and Reform Commission selected eight districts as the first low carbon development practice zones, including the Changning Hongqiao Business District. It is located in the west of Shanghai and covers an area of 3.15 km^2. Changning District has a public buildings stock of three million square meters and residential building stock of 3.8 million square meters. Hongqiao Economic and Technological Development Zone is its core area, featuring space for exhibitions, offices, dining and shopping. Tertiary industry accounts for more than 97% of the total GDP of the district.

Effectiveness and Efficiency

On March 21, 2013, the World Bank and Global Environment Facility (GEF) provided a loan and grant for green low carbon development in Changning Hongqiao Business District. This project aimed to facilitate energy-saving retrofitting of existing public buildings (hotels, shopping malls and commercial buildings), through the comprehensive energy-saving renovation of building envelope structures, lighting and air-conditioning systems. Since 2013, Changning District has carried out an energy-saving renovation in 38 existing public buildings, covering a building area of about 240,000 m^2 with an energy saving of 8404 tce and carbon dioxide reductions of over 20,000 tons.

Sustainability

The low carbon building renovation in Changning District mobilized GEF grants and World Bank loans through international cooperation, which filled the shortage of local low carbon city funds. It also introduced a set of international advanced project management methods and mechanisms, including a contracted energy management financing model. The municipal and district governments provided strong leadership and supporting policies for the implementation of the project.

Transferability

The project yielded new tools that can be applied in other districts. These included the establishment of a transparent, real-time data monitoring platform for building energy consumption, providing publicly available data and information for determining energy-saving potential and an abatement cost curve, as well as monitoring and verifying the effectiveness of energy-saving efforts. The development of an abatement cost curve provided an analytical basis for setting and allocating targets for carbon reductions, helping to shape measures and investment decisions required to achieve reduction targets. With these features, Changning district provided a demonstration for other cities in China in the selection, supervision, and financing of innovative low carbon, energy-saving renovations of existing public buildings.

Turpan New Energy Demonstration Zone – Solar Energy Utilization Project

The city of Turpan is located in the central and eastern part of China's Xinjiang Autonomous Region, with a total population of 270,000 and a per capita GDP of 41,681 yuan ($637.84). Turpan has a typical continental warm temperate desert climate with abundant sunshine and extreme dryness, with 3200 hours of annual sunshine, 5300 °C of annual accumulated temperature, and abundant solar thermal resources. The annual average temperature is 14 °C, and high temperatures of up to 47.8 °C. The Turpan New Energy Demonstration Zone was approved by the Xinjiang Autonomous Region in 2004. It is located in the eastern part of Turpan, five kilometres from the historical centre of the city. The total land area is 8.81 km^2 and the planned permanent population was 60,000 people at the creation of the demonstration zone (Table 8).

The new energy demonstration zone aims to provide solar energy for the new district and to integrate climate, urban planning, green buildings, smart microgrid management and green transport during this process. Solar thermal and ground source heat pumps are supplied to a whole building to meet heating and cooling needs; unified management is employed in the solar photovoltaic power generation, and household metering methods are used to meet resident electricity demand.

Table 8. Turpan new energy demonstration zone basic information

Location	Eastern part of Turpan, Xinjiang Autonomous Region	Population	60,000
Built-up Area (km^2)	8.81	Starting time	2008 (planning)
Area (km^2)	30		2010 (construction)
Funding sources	Government subsidies, corporate subsidies and self-financing, bank loans	Ending time	2020
Key Functions	International New Energy Technology Exchange and Exhibition Center, National New Energy Technology Research and Development Integration Demonstration Zone, Regional Public Management Service Center and Science and Technology Tourism Service Center, Sustainable Development Ecological Habitable New City.		

Effectiveness and Efficiency

By 2015, the first phase of the residential area in the demonstration area had been built, with 890,400 square meters of buildings, providing residents with comfortable indoor living conditions in Turpan's cold winters and hot summers. By 2015, the installed capacity of solar photovoltaics on the roof in the first phase of the demonstration area reached 8.7MW, with 293 residential buildings and a roof area of 61216.65m^2. The annual power generation in 2014 and 2015 was 7.298 million kWh and 10.1828 million kWh.

The annual average power generation of photovoltaics in the demonstration area was about 1.47 times the annual electricity consumption in the first phase of the residential area, reducing carbon emissions

by 16,197 tons. Five heat pump units were also put into operation, with a maximum application area of 900,000 m^2. At maximum effectiveness, the ground source heat pump system in the demonstration area can replace 28,000 tons of standard coal per year, which is equivalent to reducing carbon emissions by 69,997 tons.

Sustainability

The construction of the Demonstration Zone started in 2010, positioning itself as a model of harmonious ecological urban-rural integration, with a core mission of providing solutions to technological challenges in micro power grid. The Demonstration Zone is currently the largest and most comprehensive application of solar energy utilization in China. In 2014, it was included as one of the first batches of China's national new energy demonstration cities.

Transferability

The lessons learned in the Demonstration Zone can be applied in urban multi-story residential districts and small- or medium-sized cities. Turpan offers an example of how to maximize the use of solar energy resources using a smart micro-grid system. This project integrates meteorological observation technology into the smart dispatch of micro-grid to predict the power supply capacity of solar energy resources and ensure the safety of residential electricity and large power grids. It also uses green bus charging and energy storage systems to reduce the impact of photovoltaic power generation systems on large power grids, and a system of landscape pools to create a green and liveable environment for residents.

Guangzhou Bus Rapid Transit

Located in southern China, Guangzhou is the capital city of Guangdong Province. It is China's third largest city after Beijing and Shanghai, with a population of over 14 million and an urbanization rate of over 86%. With high population density and limited road space resources, Guangzhou is prioritizing the development of urban rail systems with low energy consumption and pollution emissions, and optimal space resources per capita. Bus Rapid Transit (BRT) is a new public transport solution that has been successfully adopted in other countries. It features low development cost, large traffic volume and low pollution.

Guangzhou's BRT was officially put into operation in February 2010. The total length is 22.5 km along the east-west layout of Zhongshan Road, from Guangzhou Avenue in Tianhe District to Xiayuan in Huangpu District. Its 26 platforms in the centre of the roadway are one of the main corridors for east-west passenger flow in Tianhe District (Figure 20).

Figure 20. Guangzhou BRT

Source: http://www.itdp-china.org/brt/city/?city_id=15&city_name=%E5%B9%BF%E5%B7%9E&lang=0

Effectiveness and Efficiency

Guangzhou BRT has shown innovation in its use of the "special corridor + flexible line" operation mode, which effectively integrates the BRT trunk line with more than 80 bus lines. It can increase the average speed of the bus from 15 km to 18 km per hour. Because of the separation of bus lanes and regular vehicle lane on Zhongshan Avenue, traffic congestion has been significantly reduced.

The Guangzhou BRT system links with subway, bicycle and walking lanes to maximize connectivity. It is the first BRT system in China to be assessed as a "gold standard" by ITDP (Institute for Transportation & Development Policy), and won the 2011 World Sustainable Transportation Award and the 2012 United Nations Climate Change "Beacon" award (ITDP, 2014).

The Guangzhou BRT has played an important role in mitigating traffic congestion. As the largest express bus transport system in Asia, Guangzhou BRT has an average operating speed of 23 km/h, which is 84% faster than conventional bus lines, with an average daily capacity of 850,000 passengers.

In addition, Guangzhou BRT has become the city's public exchange hub, integrating existing resources and technology, improving the operational services and operational efficiency of public transport, and changing the travel mode of BRT passengers, such as travel intensity and total volume, non-commuting travel. It has become mainstream of public mobility. The BRT system is reducing carbon emissions in Guangzhou by at least 86,000 tons each year.

Sustainability

Guangzhou BRT is the first system in China that belongs to multiple bus carriers. All BRT lines are operated by three groups consisting of seven bus operating companies. This mode allows the government to guarantee a high standard of service quality. The public transport information system in Guangzhou has integrated into and accessed to the intelligent public transport system of all bus companies in the city.

Transferability

Guangzhou BRT's success can be attributed to several key components, including successful planning and designing at all key stages, political supports from the Guangzhou municipal government and related departments, and the adoption of advanced technical standards. Similar systems can be adopted in large and medium-sized cities with large population density, small urban space and traffic congestion. Guangzhou BRT has become the most successful BRT project in China. It's the country's first "closed corridor + flexible line", and even the first system in Asia to achieve the passenger transport capacity of the subway.

Market-based Mechanisms: Shenzhen ETS Pilot Program

As one of China's first seven carbon trading pilots selected by the National Development and Reform Commission, Shenzhen took the lead in launching an Emission Trading Scheme (ETS) on 18 June 2013. The Shenzhen pilot ETS now covers 636 key industrial enterprises and 197 large public buildings. Its trading volume is currently at the top of the seven pilot exchanges. Compared with other pilot cities in China, the proportion of heavy industry in Shenzhen's industrial structure is small, and thus- carbon emission covered by Shenzhen's ETS is small. Nonetheless, it has the highest turnover rate due to its mature carbon market mechanism (Yang, 2017).

Effectiveness and Efficiency

Although the total carbon emissions in Shenzhen only account for a very small proportion of the total carbon emissions in the country, Shenzhen ETS Pilot Program is demonstrating the role of market mechanisms in reducing greenhouse gas emissions. Absolute carbon emissions under the ETS in 2015 decreased by 5.31 million tons compared with 2010, far exceeding the 21% reduction target set by the central government for Shenzhen during the "12th Five-Year Plan" period. At the same time, the industrial added value of the ETS covered industries in 2015 increased by 148.4 billion yuan compared with 2010.

Sustainability

Shenzhen has built sound fundamentals for ETS operation, such as legislation and a measurement, reporting, and verification (MRV) system, with legislative principles and institutional design based on local conditions. Shenzhen has successively promulgated the "Provisional Regulations on Carbon Emission Management", "Interim Measures for the Trading of Carbon Emission Rights" and other regulations. It has also implemented precise monitoring and strict verification for the ETS-covered industries and helped them actively carry out energy conservation and emission reduction. In addition, Shenzhen actively explores innovative carbon finance, such as carbon bonds, carbon funds, and financing of cross-border repurchase of carbon assets to introduce more social capital into the green finance sector.

Transferability

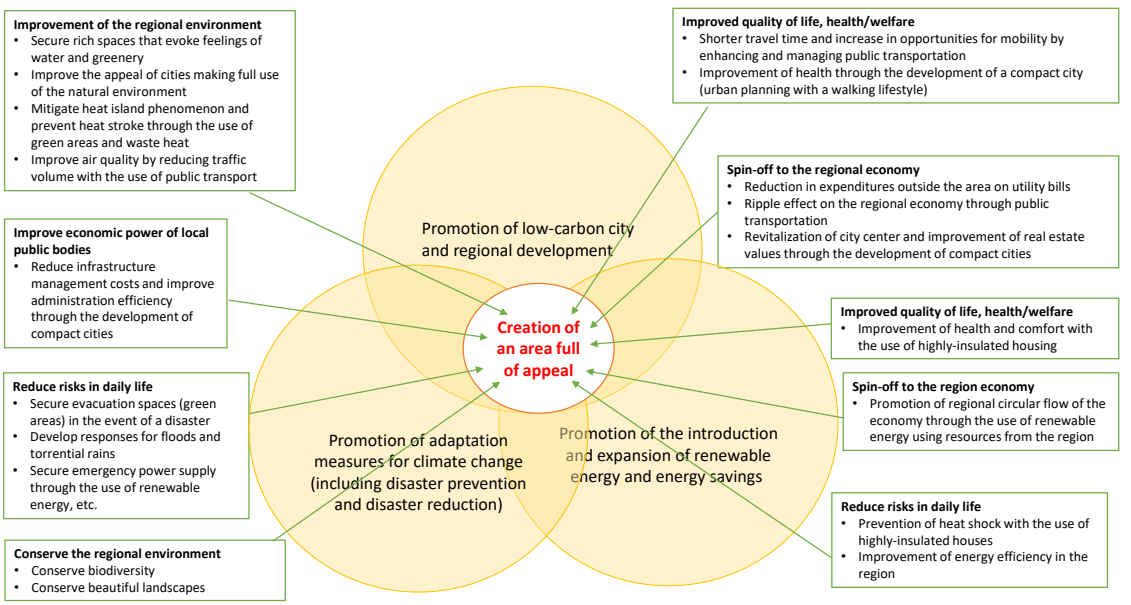
Shenzhen's ETS Pilot Program provides useful lessons-learned for other cities as well as China's national carbon emission trading system. In contrast to other pilots, the Shenzhen ETS not only includes direct sources of CO_2 emissions but also incorporates a large number of relatively small indirect sources. It has accumulated a large amount of practical experience on how to define organizational boundaries, identify emission sources, and guarantee the reliability of data acquisition in enterprise carbon emission verification. With the launch of China's national carbon market in 2017, Shenzhen ETS managers are now serving a leading role in improving the national carbon market policy system, infrastructure construction and stakeholder capacity building.

Japan

Partnerships between local governments, businesses and residents are fundamental to the development of low carbon cities in Japan. To formulate effective approaches while maintaining partnerships, it is important to clarify and share information with stakeholders. Information sharing on the co-benefits of creating low carbon cities and implementing other GHG emissions countermeasures (Figure 21) can contribute to the low carbon development of other cities.

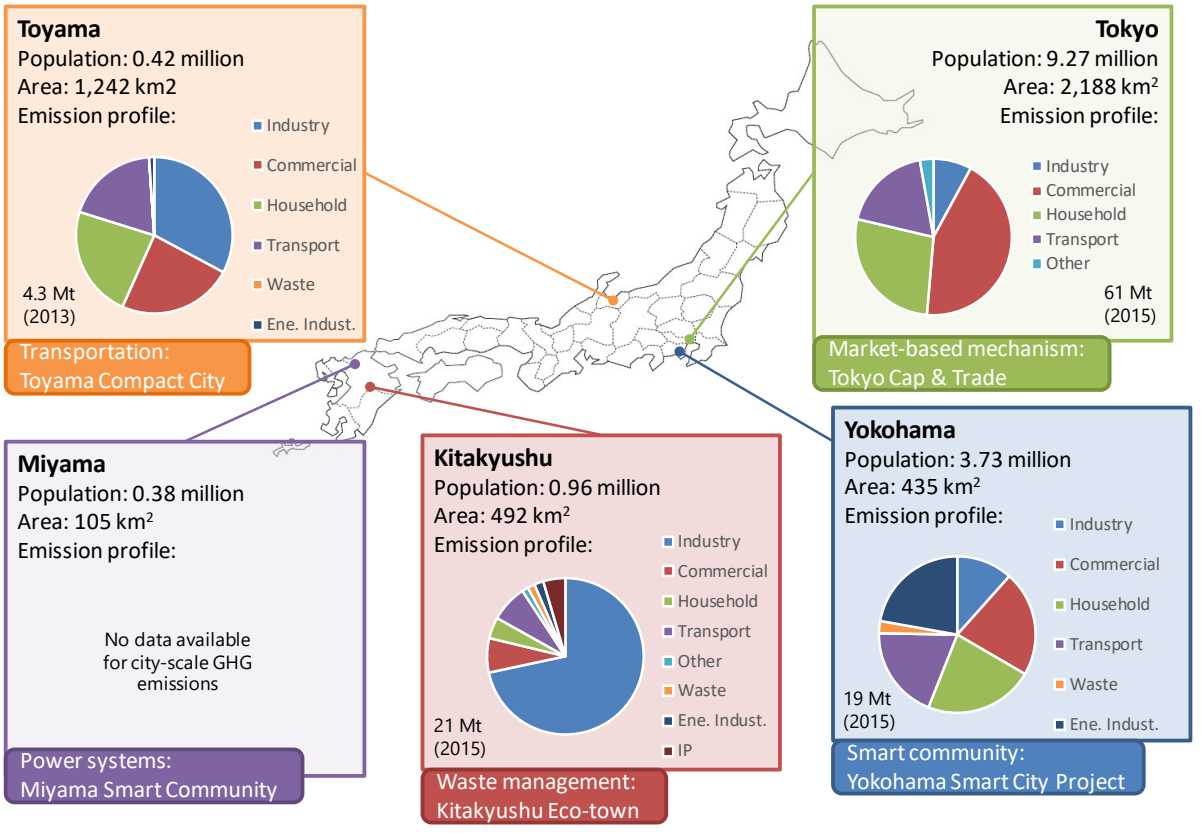
This section focuses on five cities (Tokyo, Yokohama, Toyama, Kitakyushu and Miyama) that are developing specific initiatives that will result in the low carbon development of the city (Figure 22). Low carbon cities can be created not only in mega-cities, but even by cities with only a few thousand residents by leveraging the enthusiasm and ingenuity of people taking charge, together with the use of national support systems.

Figure 21. Examples of co-benefits from global warming countermeasures



Source: Ministry of the Environment, Japan "Low-carbon City Profile – Climate Change Actions by Asian Cities in the City-to-City Collaboration Programme" March 2018. (https://pub.iges.or.jp/pub/low-carbon-city-profile-climate-change-actions)

Figure 22. Basic information on the five cities introduced in this section



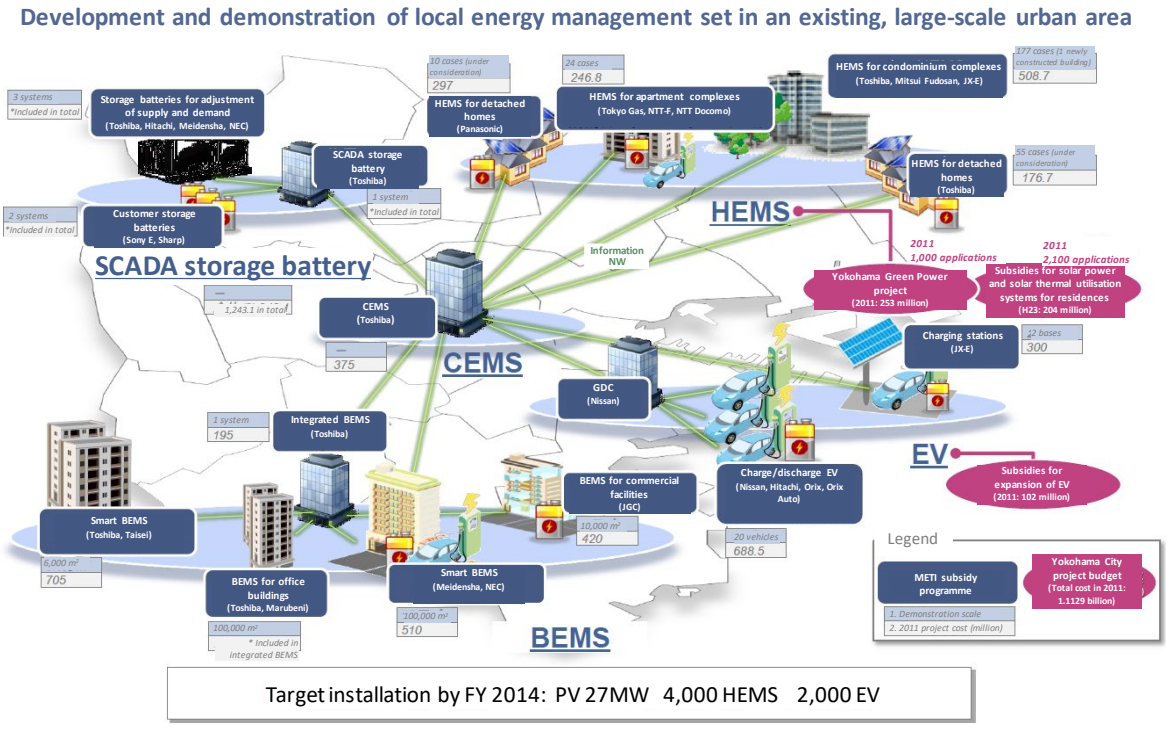
Source: IGES (2019)

Smart Community: Yokohama Smart City Project

The new growth strategy formulated by the Japanese government in June 2010 includes a policy to promote action to achieve the development and overseas expansion of a Japanese-style smart grid. Yokohama City implemented the "Yokohama Smart City Project (YSCP)" at the demonstration stage as one of the "Next-Generation Energy and Social System Demonstration Projects" developed by the Ministry of Economy, Trade and Industry between fiscal 2010 and 2014. Their mission is "to lead in establishing a world's best smart city model in Yokohama - the state-of-the-art city with a population of 3.7 million - and export Yokohama's solutions to cities overseas". Towards the mission, Yokohama City has collaborated with 34 companies to implement 15 projects and verified the applicability of advanced technologies which are almost at the stage of practical application. With the Great East Japan Earthquake that hit Japan in March 2011, peak-shifts and peak-cuts of electric power demand were also included as one of the objectives in the development and expansion of this demonstration project. In practice, it was an experiment on technologies and applications to promote dispersion of electric power peaks, demand responses, and reductions in the total electricity consumption by visualising the use of electricity to the demand side, utilising local energy management systems centred on Community Energy Management System (CEMS) (Figure 23). This experiment provided useful feedback in such areas as policy planning by the national and municipal government, improvement of technologies and systems of corporations, and energy-saving

behaviour by residents. Since 2015, Yokohama City has moved from the demonstration to the expansion stage, taking full advantage of the technologies and knowledge developed through the YSCP. To accomplish this, the Yokohama Smart Business Association (YSBA), a new public-private collaborative council, was established. The city is thus taking steps to create an energy-circulating city with superior capabilities in disaster prevention, environmental performance and economic efficiency (City of Yokohama, 2017).

Figure 23. Overview of Yokohama Smart City Project (YSCP) (excerpt)



Note: HEMS – Home Energy Management Systems; BEMS – Building Energy Management Systems; CEMS – Community Energy Management Systems; FEMS – Factory Energy Management Systems; EV – Electric Vehicles, SCADA – Supervisory Control and Data Acquisition.
Source: Yokohama City, Yokohama Smart City Project (YSCP) General Meeting, March 24, 2015. (Partial modification) (https://www.city.yokohama.lg.jp/kurashi/machizukuri-kankyo/ondanka/etc/yscp/yscp02.files/0003_20190312.pdf)

Effectiveness and efficiency

Effects of reducing greenhouse gas emissions

Under the YSCP, 4,200 HEMS (4,000 projects), 37 MW of PV (27 MW), and 2,300 EV (2,000 vehicles) were introduced, which reduced 39,000 tonnes (30,000 tonnes) of CO_2 emissions, which exceeded the original targets shown in the parenthesis.

Activities and promotional system for the YSCP demonstration project

While diverse demonstration experiments were carried out under the YSCP, major experiments include large-scale experiment on energy-saving behaviour with the participation of about 3,500 households who introduced Home Energy Management System (HEMS); experiment on the optimal use of energy

at the local level by the management of the business and commercial buildings; and experiment on charging/discharging EV systems assuming EV as social infrastructure that can store electric power. These demonstration experiments clarified effective pricing and incentives to promote peak cuts and peak shifts of electricity usage in the city area and contributed at the national level to designing a market system for trading saved electricity.

YSCP is a project carried out in partnership among the government and companies that are interested in developing a Japanese-style smart grid. The national government provided 60% of the total investment (about JPY 13 billion), and the private sector contributed the remaining 40%. The local government did not make a direct investment but provided support from the sidelines by liaising and connecting stakeholders in the project. The Climate Change Policy Headquarters in Yokohama City Government is designated to manage actions related to climate change across departments, and the project promotion section within this office is in charge of the YSCP. As the section often need to consult with the private sector, the team has a diverse range of personnel with specific knowledge in such areas as civil engineering, electric power, and machinery.

Development from YSCP demonstration stage

Yokohama City, which experienced paralysis of its administrative functions as a result of power outages caused by the Great East Japan Earthquake, has applied the knowledge gained through the YSCP in the reconstruction of the city's Minami Ward Office. Specifically, Yokohama City has strengthened energy security in the city office by introducing the latest co-generation systems and creating a system to collectively manage energy using BEMS among neighbouring facilities. That is, through an energy cooperation network with the municipality's central hospital and Minami Civil Engineering Office which are adjacent to the city office.

In addition, aiming to strengthen disaster preparedness in the area, a project is being developed through public-private partnership, to set up a virtual power plant (VPP)[23] in local elementary and junior high schools.

Sustainability

Yokohama City announced in October 2018 that it would aim at a "Zero Carbon Yokohama", in its four-year interim plan (2018-2021) and the Yokohama City Action Plan for Global Warming Countermeasures. The low carbon development of cities is also an important part of city planning. YSCP has been recognized as a key measure to achieve low carbon development and is supported by policy. Yokohama Smart Business Association (YSBA) was launched in 2015 as an organisation promoting initiatives to implement the YSCP. As of April 2018, 17 private companies and Yokohama City participate in YSBA.

Transferability

In order to ensure that a project is feasible, it is necessary to consider with whom and how it will be organised at the planning stage. In the case of YSCP, even before the start of the national government's

[23] This is a mechanism to adjust electric power supply and demand by functioning as if it is a single power station. It remotely integrates and control EVs, storage batteries and power generation equipment in held in buildings and households. In Yokohama City's VPP project, electric power providers install storage battery facilities in elementary and junior high schools in the city that have been designated as local disaster preparation bases. The city aims to develop actions to use the VPP is used to adjust supply and demand for electric power during normal times and while the City can use it as a source of power supply during emergencies which involve a power outage.

project, the public and private sectors had their own ideas, which were exchanged among them. In addition to device and system companies, electric power and gas supply companies were also included as energy suppliers to implement the project, which may have enabled the project to develop further after implementation. The VPP developed by Yokohama City has attracted the keen interest of other municipalities and thus the city created business opportunities for local companies through the provision of information on appropriate know-how and acting as an intermediary for YSBA companies. Furthermore, Yokohama City, which is actively engaged in the development of international environmental cooperation, is also promoting activities to disseminate information through the organisation of the Asia Smart City Conference and transfer the technologies and environmental management know-how developed in the city as a package in cooperation with cities, such as Bangkok and Batam.

Conclusion

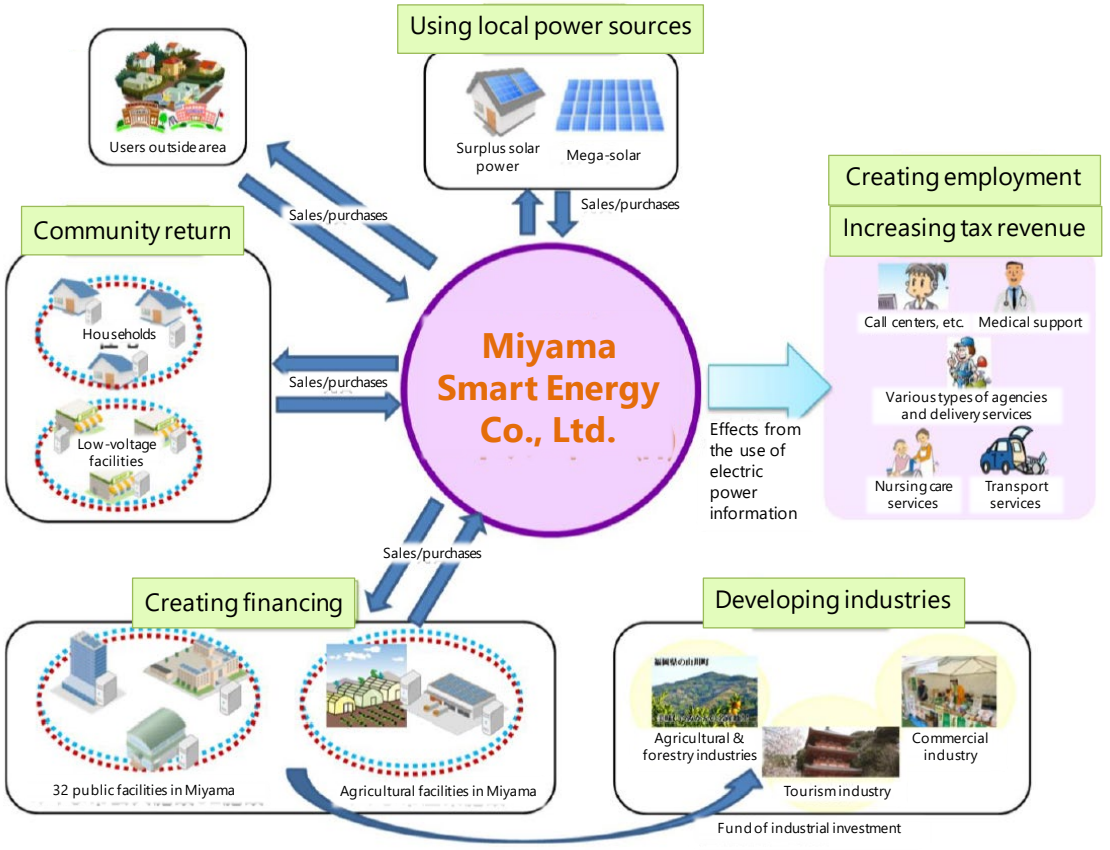
Clearly, Yokohama City is actively promoting to decarbonise the city, as seen in its commitment to the "Zero Carbon Yokohama" plan and establishment of the Climate Change Policy Headquarters. Public-private cooperation is essential to achieve decarbonisation. Thus, Yokohama City secured the cooperation of companies willing to work together by demonstrating the City's proactive approach towards cutting-edge initiatives, as well as business opportunities both in Japan and overseas that local action may lead to. As a part of the support mechanism, the city government established an administrative body to monitor trends in both Japan and overseas. With such proactive engagements, Yokohama will be able to develop initiatives that can simultaneously achieve the creation of a city that is both liveable and decarbonised.

Power systems: Miyama Smart Community

In Japan, renewable energy originating in municipalities has increased, the concept of distributed (decentralized) energy has been more widespread, and the market for retail electricity sales has opened up. With those backgrounds, municipalities are increasingly investing in electric power companies and promoting the local production and local consumption of renewable energy (Tominaga & Hayashi, 2018). Among them, Miyama Smart Energy (Miyama SE), founded in March 2015 with investment from Miyama City[24], has become known as the first company that trades low-voltage electricity with households (retail sales of electric power, purchase of excess solar power). Through Miyama SE, Miyama City has developed a business model of the economic cycle which realizes a smart community by promoting the local production and local consumption of energy and thus retaining the cash flow from electricity consumption within the city, as well as providing comprehensive support services using IT. With this initiative, the city aims to revitalise the local economy and create local employment and offer services to address local issues stemming from population decline, the outflow of younger generations, and the shrinking of the local economy. Miyama's efforts have been widely recognised in Japan, including the Gold Award in the Good Design Award in 2015. There are a number of local governments that have a strong interest in investing in new forms of electric power from the perspective of securing financial resources needed to provide for resident services, and thus Miyama's knowledge and systems are being shared through collaboration between municipalities.

[24] Total investment was JPY 20 mill. The Miyama city government covered 55% (11 mill.), 40% from local businesses (8 mill.) and 5% was from a local bank (1 mill.).

Figure 24. Business model for the circular flow of the economic system in Miyama City



Source: Miyama Smart Energy Co., Ltd. https://www.ider-project.jp/stage2/feature/00000178/file03.pdf

Effectiveness and efficiency

Effects of reducing greenhouse gas emissions

The measures by Miyama City are implemented as policies aiming to achieve economic independence, boost local employment and offer stability for people settling in the area. Low carbon development of the region is not considered as a primary objective. However, since activities are being carried out using renewable energy as the community's power source, the initiative resulted in the low carbon development of the area. According to the state of CO_2 emissions from city-affiliated facilities in Miyama City, CO_2 emissions were already suppressed from 11,000 tonnes in 2005 to 9,264 tonnes by 2015 as a result of promoting energy-saving activities (Miyama City, 2009). In 2016, the year after Miyama SE was established, emissions were estimated to have reduced further to 7,826 tonnes, which is about a 30% reduction from 2005 levels (Miyama City, 2017).[25][26]

[25] Miyama City "Efforts of Miyama City for local energy production and consumption and smart community" Dec. 22, 2017.

[26] In "Methods of handing FIT electricity in calculating actual emission factors" (June 27, 2016) from the secretariat of the study group on calculation methods for emission factors by business based on the Global Warming Act, the characteristics and advantages of not discharging CO2 from electricity (FIT electricity) are said to be thinly and widely attributable to all customers who bear costs with the receipt of subsidies from the Feed-in Tariff (FIT) system. According to this policy, Miyama City cannot appeal the CO2 emission reduction effects shown here. However, in this report, it should be noted that this is indicated as a reference value, taking into consideration that Miyama City has its own subsidy menu for spreading renewable energy power sources and is committed to achieving this project, including securing connection access points.

Local production and local consumption of energy

Looking at the composition of the city's power supply from Miyama SE as an indicator of the state of local production of energy, renewable energy makes up 20% of the total energy supply in the city, while the remainder is procured from a major power company. Miyama City demonstrates a diffusion rate of 10.8% for solar power generation, which exceeds the nationwide average of 6.6% because of the city's abundance of sunshine due to its location. Thus, renewable energy in the city is mostly from mega-solar projects in which the city has invested and surplus solar power from households.

The total amount of power contracted from Miyama SE, as an indicator for the state of local energy consumption (power consumption) in the city, was 54,000 kW (as of the end of April 2018). The project strategically prioritized to secure large-scale customers to stabilise business viability, and it succeeded to secure contracts with about 400 high-voltage customers (36 city-related facilities, public facilities in neighbouring municipalities, private facilities). Although Miyama SE supplies power to approximately 4,000 low-voltage customers (households), there is still a large gap in its coverage, considering the total number of households in Miyama City (about 14,000 households). It is thus needed to further capture small retail customers to literally achieve the local production and local consumption of energy.

Response to local challenges

The launch of Miyama SE to promote the local production and local consumption of energy and develop resident services using IT has created about 50 new jobs (NHK Television, 2018) and is leading to the development of new industries. Miyama City has also developed resident services through Miyama SE, including online shopping and miscellaneous services, elderly monitoring services using HEMS, dissemination of government information, and the management of Sakura Terrace, which is a community space used in combination with restaurants that source local ingredients. All of these services are a return of the profits obtained through electricity sales back to the residents, which may be a unique strength for the modality of local government investment in new power. An additional economic effect has been an increase of inbound visitors from all over the country to study the initiative, which has contributed to revitalising the local economy (Miyama City, 2016).

Sustainability

In order to ensure sustainability, it is essential to stabilise business viability and foster understanding of the stakeholders in the city. To ensure business viability, power sources and suppliers must be secured, but it is also necessary to materialize the idea of the local production and local consumption of energy. Although it is difficult to create new renewable energy power sources in the area due to decreasing subsidies for solar power generation and system constraints [27], Miyama City intends to secure power sources for Miyama SE, by widely purchasing photovoltaic power generated in households, including those in neighbouring municipalities, in addition to the already secured renewable energy power sources.

There is a risk of losing buyers of their electric power, particularly the commercial entities, when other operators can offer less expensive electric power supplies. So far, the city has managed to secure

[27] There are power system constraints in terms of capacity and fluctuation. For example, where there is rich with photovoltaic power like Kyushu island, renewable energy output may be limited on a warm sunny day with low energy consumption in order to avoid imbalance of electricity demand and supply, which may cause blackout whole island at a worst case. This is regarded as business risk.

continuous contracts by getting the buyers' understanding and supports on the philosophy of regional revitalization and regional circular economy. With regards to power supply to households, although nearly 70% of residents are aware of the smart community activities, this knowledge is not sufficiently linked to changeovers in electric power supply contracts, and they need to capture this potential clientele.

As part of efforts to promote understanding by stakeholders, Miyama City encourages younger people to learn about sustainable, bottom-up community development activities and is developing classes for elementary and junior high school students in the city with the purpose of deepening their attachment to their hometown.

Transferability

Miyama City's activities made significant progress because there were human resources who foresaw that introduction of Feed-in-tariff (FIT) would give an opportunity for the municipality to sell electric power at retail prices, the leadership of the mayor who had a significant interest in the regional circular economy, and available support mechanism by the national government. In the electric power retail industry where differentiation is difficult in terms of price and quality, in particular, the "early bird catches the worm" mentality is strong in terms of the development of power supply and a customer base. The fact that Miyama City was able to develop this project in a timely manner is a major factor in its success.

In Japan, there are about 100 municipalities that have a strong interest in investing in new forms of electric power from the perspective of securing financial resources for resident services. There would be opportunities to offer consulting services for these municipalities, through Miyama Power HD Co., Ltd., one of Miyama SE's investors. Since the start of cooperation with Ichikikushikino City and Kimotsuki Town in Kagoshima Prefecture in March 2016, Miyama City has also established new agreements with several municipalities in Kyushu, Kanto (East) and Tohoku (North-East) regions to provide know-how on the electric power business and transfer the experience of the development of new electric power with investment from local governments.

A prerequisite to transferring the experience in developing new electric power sources with investment from local governments is ensuring certain scale of operation to secure business profitability of the power business and, in addition to power supply, to secure connection to the power grid, which are apparent constraints in Japan.

Conclusion

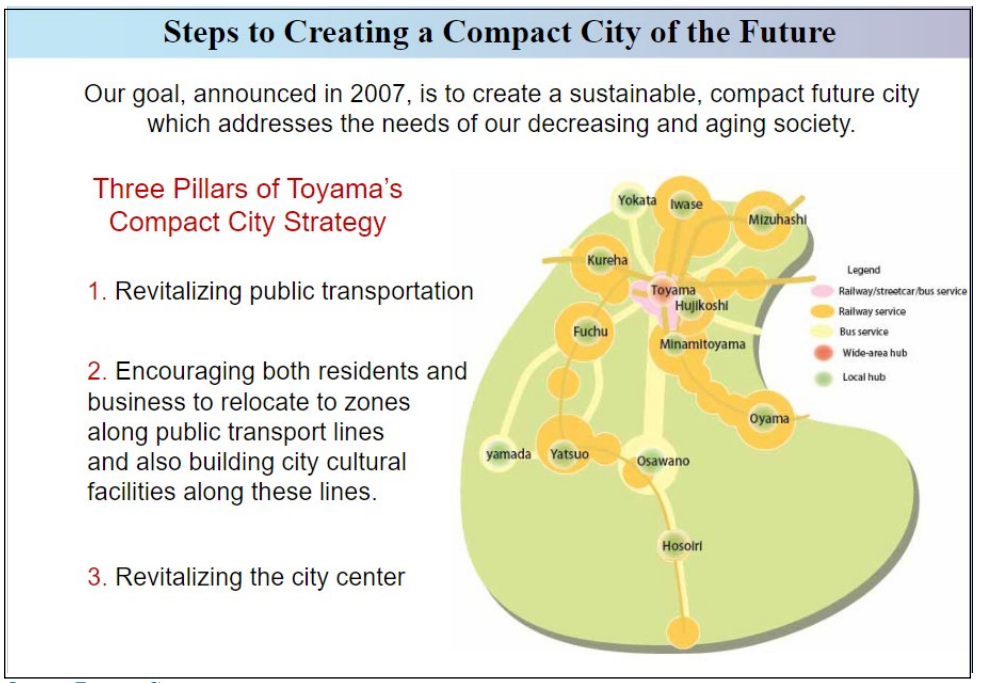
Miyama City has achieved the circulation of energy and biomass within the city by connecting the dots of existing resources scattered around the city by lines of electric power and IT. The city is working to improve services to its residents by improving tenacity with secure renewable energy sources in the city and retaining the flow of financial resources within the city. This is a good example that even a small regional city with populations of 30,000 is able to create a low carbon, sustainable and liveable smart community using bold ideas and ingenuity. These activities have now moved past the early days and entered a period of growth with further developments expected in the future.

Transport: Toyama Compact City

Overview

Toyama City's Compact City policy has been advocated by the mayor of the city as a solution to various urban challenges, including concerns over the anticipated increase in administrative costs due to falling birth rates and ageing demographics, population decline, and the low population density of the urban area, deterioration of public transport because of the excessive dependence on private vehicles, which has made the city a difficult place for people to live without a car, and rising CO_2 emissions due to the city's sprawling urban structure (Toyama City, 2018). Toyama City is aiming to achieve an urban structure (multipolar compact city) of "dumplings and skewers" where public transports (skewers) connect not only within the city centre, but also with other local centres (dumplings) through the city for compact urban development. With the planned introduction of the Hokuriku shinkansen (bullet train) line by Japan Rain approved in 2001, Toyama introduced Japan's first full-scale Light Rain Transit (LRT) built by the public sector and operated by the private sector, i.e., Portram line, which runs northward from Toyama Station, and the Centram line, which loops around the city centre on the southside of the station. The city improved mobility by linking these two lines and connecting them with urban and suburban trains. Together with improvements to the public transport network, the city also integrated measures to revitalise local centres along the railroad tracks to encourage people to move to those areas.[28] By implementing measures to enhance infrastructure and incentivise changes in public awareness and lifestyles, Toyama City is, slowly but surely, moving closer to the type of town development where people can move around the city on foot.

Figure 25. Toyama's basic policy for the creation of a compact city



Source: Toyama City

[28] Assistance for business operators constructing apartment buildings in a common residential area along a public transportation line (subsidies for construction costs of apartment building (JPY 1 million/unit), assistance for construction costs for high-quality rental homes (JPY 1.2 million/unit), assistance for residents purchasing detached homes or apartments (subsidy for loans for the purchase of detached homes or apartments (JPY 500,000/unit), subsidies for rent with relocation to city centres (JPY 10,000/month, 3 years), subsidies for renovations (JPY 300,000/unit)) (Yoneyama, 2017).

Effectiveness and efficiency

Effects of reducing greenhouse gas emissions

Toyama City has promoted low carbon city development under two of the Cabinet Office's programmes, the Eco-Model City programme (selected in 2008) and the Future City programme (selected in 2011). The basic policies stated as part of this initiative include promoting the revitalisation of public transport, promoting the concentration of urban functions in the city centre and along public transport lines, and promoting eco-lifestyles combined with compact urban development and eco-activities by companies. Included in these policies are the development of an LRT network, shift from the use of automobiles to public transport, expansion of small-scale hydroelectric power generation, and "Team Toyama" initiative, which promotes activities in which residents, companies, and the government work together as a team. Although the volume of CO_2 emissions in Toyama City rose by about 16% between 1990 and 2005 (Toyama City, 2012), as a result of the promotion of these activities, the city was able to steadily promote low carbon development with the achievement of an 8.9% decrease in emissions in 2014 (3.9 million tonnes) from 2005 levels (4.2 million tonnes) (Mori, 2018).

Effects of compact city policies

The Compact City policy aims to create a virtuous cycle that will lead to the revitalisation of the city, increase tax revenue, and improve the name recognition of Toyama, while also advancing low carbon development by promoting the development of a walkable, liveable city. For this reason, Toyama is engaged in improving public transport, such as the LRT, promoting the construction of housing along public transport lines, and revitalising the city centre, which so far achieved certain positive effects. For example, the number of users of public transport has risen with the development of the LRT and the mobility in particular of the elderly during the daytime has improved (Morotomi, 2018). The proportion of residents living in areas with convenient access to public transport has increased from 28% (2005) to 37% (2017). Looking at economic effects, land prices around Toyama Station and the loop line have risen by 3-5% (compared to the average 0.2% increase in land prices throughout the city). Along with the land price increase, revenue from property taxes and city planning taxes for the FY 2018 budget cycle have increased by about 8% since FY 2014 (Morotomi, 2018). Property taxes and city planning taxes are core taxes that account for 47% of city tax revenue, so concentrated investment in central urban areas is rational and effective from the perspective of a return of benefits to taxpayers. In addition, the total value of urban redevelopment projects is JPY 81.88 billion, of which tax income is JPY 41.75 billion, which illustrates that public investment can succeed in triggering private investment (Toyama City, 2016). The population of Toyama city is on a downward trend, just as is seen in Japan and Toyama Prefecture. However, a turning point occurred in 2010, when the inflow of people to Toyama City from outside the Toyama prefecture rose more than the outflow and the population's rate of decline showed a slowdown compared with the rest of Toyama Prefecture. In this way, the anticipated effects are emerging thanks to the simultaneous promotion of policies to develop infrastructure and revitalise the city.

Sustainability

The Compact City policy is being advocated under the strong leadership of the Mayor and is being promoted together with the Toyama City Master Plan and various other administrative plans. Toyama City is a model city selected under the national government's Future Cities Initiative and Local Government SDGs programmes,

and above all, the compact city policy is the key policy. In order to continue to promote policies such as these, it is important to build up achievements by deploying various initiatives in collaboration with stakeholders both inside and outside of Toyama under a consistent concept. It is also important to gain residents' support for the policies, ensuring their understanding that disseminating the achievements of these initiatives to the outside world and thus gaining recognition of the city will eventually lead to an improvement in their quality of life.

It is also essential to improve governance. For example, in city hall, the Environmental Policy Division, which is responsible for the Eco-Model city programme and others, is building a framework for cross departments collaboration, which invites ideas for low carbon development measures and reports on indicators that raise the awareness of staff. On the private sector side, "Team Toyama", which was established by companies and organisations to promote global warming countermeasures in 2008, and the Platform of Environmental Citizenship Toyama, which was launched in 2018 to promote the SDGs, are carrying out educational activities in collaboration with the local government. In addition to this, Toyama is also developing a system to promote urban development in collaboration with academic institutions, such as Toyama University.

Transferability

Toyama City's compact city planning and environmental measures have gained international recognition. It was selected by OECD as a city with advanced compact city policies, for the Sustainable Energy for All (SE4ALL) global initiative, and as one of the 100 Resilient Cities (100RC). Toyama City has also taken part in the World Bank's "City Partnership Program" and has disseminated information all around the world. Toyama City is also making an effort to formulate intercity cooperation activities mainly with Southeast Asia to disseminate the city's environmental administration as well as the strengths of local businesses in the city in an easy-to-understand way to a wider audience. To support the expansion of business operation of local companies to overseas, the local government and companies have teamed up and travel together to the prospective sites. It aims to gain confidence in the potential counterpart, which is considered a challenge without public office's involvement. Toyama city is also formulating concrete projects of city-to-city cooperation, taking advantage of support from the national government.

Conclusion

Toyama City has promoted its Compact City policy to build up the creation of a walkable and liveable city. This is a fundamental policy for sustainable city planning, and by promoting this policy, the beneficial effects are emerging in all aspects of the environment, economy and society. Budgetary, human resource and institutional support are needed when implementing various projects, but there are limits to what governments can do alone. One of Toyama City's strength is that through so many years of promoting the Compact City policy, it has developed a mechanism that can maximize the use of resources through cooperation among industries, academia, the government, and civic society. Toyama City, which was selected as an SDGs Future City in June 2018, will be undertaking an SDGs model project on "Expanding the compact city through the integration of the LRT network and autonomous energy management",[29] which is expected to further promote low carbon development in the city.

[29] Local Government SDGs website

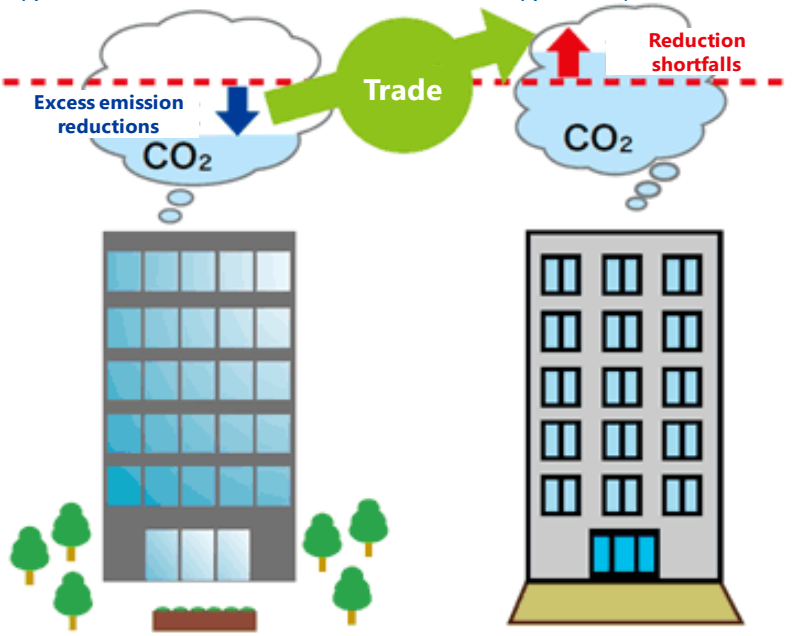
Market-based mechanism: Tokyo Cap & Trade

Tokyo is a large metropolis with a population of about 14 million and a level of GHG emissions that is on par with that of Austria and Greece. Recognizing the critical importance of major cities to promote low carbon societies as a measure to counter climate change, Tokyo set a target to reduce its GHG emissions by 25% by 2020 from 2000 levels in its urban strategy, "Tokyo's Big Change - The 10-Year Plan" (2006). In 2007, the metropolitan government announced the "Tokyo Climate Change Strategy", which outlined the basic policies for all stakeholders that required specific measures to create a new urban model that could respond to the risks of climate change. One of the policies, "impose the obligation to reduce total emissions on large CO_2-emitting business establishments and institute an emissions trading system", has been shaped into the Tokyo Cap & Trade (Tokyo C&T). This became the world's first urban cap and trade system for the industrial and business sectors. CO_2 emissions from these sectors account for about half of the Tokyo metropolitan area's emissions. (Tokyo Metropolitan Government, 2018). Prior to that, Tokyo introduced the "Global Warming Countermeasures Planning System" based on the Ordinance to Improve the Urban Environment and Protect the Health of Citizens (Environment and Health Ordinance) and had promoted voluntary initiatives by business operators since 2002. However, the Environment and Health Ordinance was revised in 2008 because significant effects were not seen, and an obligatory system was introduced. As a result, owners of target business establishments are required to reduce CO_2 emissions as prescribed during the reduction plan period and improve implementation systems within the company. By voluntary initiatives or purchasing credits[30] generated by others, business owners need to fulfil their reduction obligation.[31] Since this system started, large-scale business establishments have achieved significant emission reductions of 26% by 2016 compared to the base year. At the same time, it has also moved towards creating a low carbon society, such as raising awareness in businesses about energy conservation and improving energy management capacity. Tokyo has already started to consider systems for the third planning period (2020 to 2024) as a new stage to promote initiatives to achieve the 2030 target, focusing on creating a decarbonised society post-2030 and moving forward in promoting low carbon development through intensive energy savings.

[30] There are five different types of credits permitted by the Tokyo Metropolitan Government: excess emission credits, small and mid-sized facility credits in Tokyo, renewable energy credits, outside Tokyo credits, and Saitama credits.

[31] If reduction targets cannot be achieved, a reduction of 1.3 times the shortage will be added to the next reduction target. In the event that there is a violation of these orders, the business operator shall pay a fine (up to JPY 500,000) and the details of the violation shall be made public.

Figure 26. Illustration of emissions trading in Tokyo



Source: Tokyo Metropolitan Government

Effectiveness and efficiency

Effects of reducing greenhouse gas emissions

Caps under the Tokyo C&T are set by back-casting from the 2020 target. Caps are set at 8% or 6% in the first commitment period and 17% or 15% in the second commitment period. As a result of a sincere effort to conserve energy in the workplace, Tokyo achieved a 25% reduction in base year emissions (1,650 tonnes) in 2014, the final year of the first planning period. 91% of business establishments (1,262 businesses) implement their own energy conservation measures, with the remaining 9% (124 businesses) fulfilling their obligation through emissions trading.

The achievements under this system are attributed to the promotion of energy conservation activities by business operators and updating of facility and equipment for energy efficiency, as well as an even more ingrained awareness about energy efficiency reflecting the 2011 Great East Japan Earthquake. Achievements steadily continued, and in the second year of the second commitment period (2016), Tokyo achieved a 26% reduction from the base year. It is expected that nearly 80% of businesses will be able to achieve their obligations through their own energy conservation measures.

Both the total amount of emissions and the CO_2 emission intensity per total area of the business establishment are falling. The standard unit for office use in 2014 has decreased by 30% from the base year. While the final amount of energy and CO_2 emissions show the same declining trend in both at the national and metropolitan industrial and commercial sectors, the effectiveness of the system can be observed as the level of reduction at the Tokyo metropolitan level is twice that of the nationwide

level since the implementation of Tokyo C&T (Tokyo Metropolitan Government, 2018). Although there are concerns about the possibility that Tokyo's economic vitality could be undermined by a cap on the CO_2 emissions of companies issued before the system was implemented, decoupling is moving forward whereas final energy consumption in Tokyo is decreasing while gross production in the metropolitan area continues an upward trend, demonstrating that this fear is proving unfounded.

Secondary effects from Cap & Trade

There has been a change in the perception that the design and implementation of the Tokyo C&T system have been guided not only by regulations but also by the public and private sectors working together, rather than the traditional top-down approach. For example, the system has been revised to be more effective based on feedback from business operators. That includes improvements from a mechanism in which only the owner of the tenant building is responsible for emission reduction to a mechanism which requires the cooperation of tenant business operators, as well as the provision of incentives to reduce the reduction obligation by certifying businesses with particularly successful systems, facilities and operations as top-level companies. The "Tokyo★Energy-Saving Chart" has also been created based on the Global Warming Countermeasures Implementation Plan submitted by large-scale businesses. This chart contains information, such as CO_2 and energy emission sources of certain businesses and workplaces with similar applications located in Tokyo, as well as the status of the introduction of energy-efficient equipment. It is intended to increase understanding of the status of the company to be used to further promote energy conservation activities, referring to the state of the initiatives of other companies. The use of such detailed data also enables to carry out consultations with companies. With increasing opportunities to communicate with businesses, the metropolitan government have been strengthening the system, such as gathering engineering professional staff with specialised knowledge on electric power and machinery from other departments in the Global Environment and Energy Department in Tokyo Metropolitan Government's Bureau of the Environment, under which jurisdiction the Tokyo C&T falls.

This system is leading to increased awareness of employees on energy conservation, including top management in companies, as well as improved capacity to manage both the environment and energy. In the developer industry, business operators with higher skills in energy management are increasingly recognized. In response to the growing demand for energy-efficient equipment, the perspective of energy conservation has been actively incorporated into product development. The experience of addressing energy conservation shows power savings also offers economic benefits and create a virtuous cycle in which global warming countermeasures can be promoted from a management perspective.

Sustainability

This system is implemented under the Environment and Health Ordinance. Reduction targets are periodically raised, and measures to achieve obligations are reviewed based on international trends to develop business activities. In order to continue with these efforts, the operation must be managed in a stable and steady manner. With the operation of the system to date, the organisation within the metropolitan government has been improved, including the assignment of necessary personnel in responsible sections and increasing the number of staff. Since there is also a various occasion to discuss countermeasures with businesses counterparts, there has been intense focus on human resources development for new staff, such as training courses for energy managers and the conduct of energy-saving diagnoses on site. In this way, Tokyo is ensuring that activities are

sustainable, while also strengthening governance within the metropolitan government.

Transferability

This system targets companies that are sources of large-scale emissions. Companies accepted this system because the metropolitan government convinced the companies that policy packages developed in 2007 were for all stakeholders and the policy measures on them are part of this process. Promoting policies to avoid a sense of unfairness can be identified as an important perspective for transferability. It is also essential to build a mechanism that can compile data because it is impossible to ensure the effectiveness of the system without accurate and complete information. For this purpose, it is necessary to reach a common understanding between companies and the government and to tenaciously promote continuous dialogue to build trust. This system is also being carried out over a wide area in cooperation with Saitama Prefecture.

Tokyo C&T is renowned globally as an effective system that leads to a reduction in GHG emissions. Tokyo is developing information dissemination and cooperation activities through The Large Cities Climate Leadership Group (C40) and the International Carbon Action Partnership (ICAP).

Conclusion

The Tokyo Metropolitan Government recognises that it is the mission of large cities to protect the living environment of its residents and contribute to the protection of the global environment. Tokyo is developing various actions under the various policy packages such as those in 2007. Tokyo C&T was introduced as one of those efforts. It was originally designed to ensure effectiveness based on the local situation, and it actually encouraged business establishments in Tokyo to significantly reduce emissions. The Great East Japan Earthquake and the resulting power failures, which occurred just after the launch of this system, had a major impact on the awareness of residents on energy conservation. Yet the existence of the system was an additional push for the energy conservation behaviours of businesses.

Waste management: Kitakyushu Eco-town

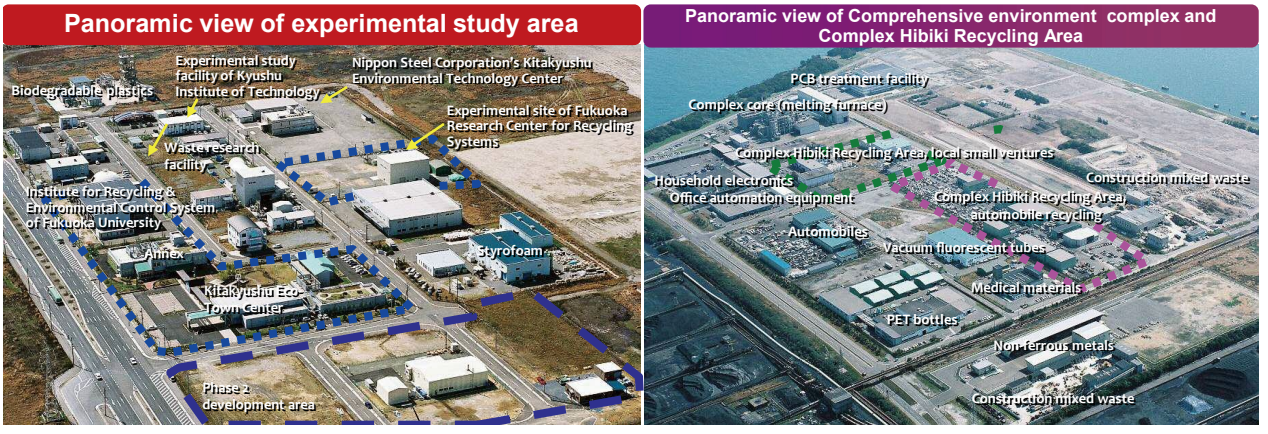
With the waste disposal problems that emerged in the 1980s and the persistent economic downturn that Japan faced after the collapse of the bubble economy, the Eco-Town Project[32] was launched to achieve the concept of "zero emissions"[33] proposed by the United Nations and promote industrial and regional revitalisation through recycling. Kitakyushu Eco-Town was one of the first regions approved for the project, which started in 1997. Kitakyushu City was one of the key drivers of high economic growth in Japan in the 1960s. It is also known throughout the country and overseas for its experience with debilitating pollution during the period and its success in overcoming this challenge in collaboration with industries, the government, academia and civic society and transforming into a city of environmentally friendly economic growth (green growth). Kitakyushu Eco-Town is the concentration and development of companies and practical research facilities mostly associated with the recycling industry located on idle land (about 2,000 ha) in the Hibikinada district[34]. It has been developed as an industrial estate, corresponding

[32] In this project, the Ministry of the Environment and Ministry of Economy, Trade and Industry approved the Eco-Town plans formulated by municipalities and provided support for hard infrastructure projects (development of cutting-edge recycling facilities, development of R&D bases, etc.) and soft infrastructure projects (dissemination and development, provision of information, etc.). By 2005, 26 areas had been approved as Eco-Towns.
[33] Concept proposed by the United Nations in 1994 aiming at reducing all waste to zero through the mutual use of resources.
[34] The Hibikinada district is regarded as an advantage because of its vast area, a completed final disposal site, proximity to industrial concentrated areas and consumption areas, and well-developed logistical infrastructure.

to the increasing emphasis on a resource-recycling society that takes regional characteristics into accounts, such as the well-developed industrial infrastructure in the city, a network of industries, government, academia and civic society formed through its experience in overcoming pollution, and the competitive edge afforded by the Hibikinada district.[35]

It is a comprehensive development from basic research and development of technologies to business development (Figure 27). Kitakyushu City offers subsidies for business feasibility studies and technology development and provides a one-stop service for various administrative procedures at each development stage. About 20 years since the start of the project, with the injection of JPY 78 billion in direct investment, 26 companies operate 27 projects employing about 1,000 people at present. In line with its original target, Kitakyushu Eco-Town demonstrated the economic effects of promoting the environmental industry. Studies are being carried out on the development of next-generation circulation industries, the establishment of a regional resource circulation zone, and the sophistication of existing material circulation industries, to ensure that Kitakyushu Eco-Town fulfils its role as social infrastructure for sustainable development of Kitakyushu City.

Figure 27. Panoramic views of Kitakyushu Eco-town



Source: Kitakyushu City

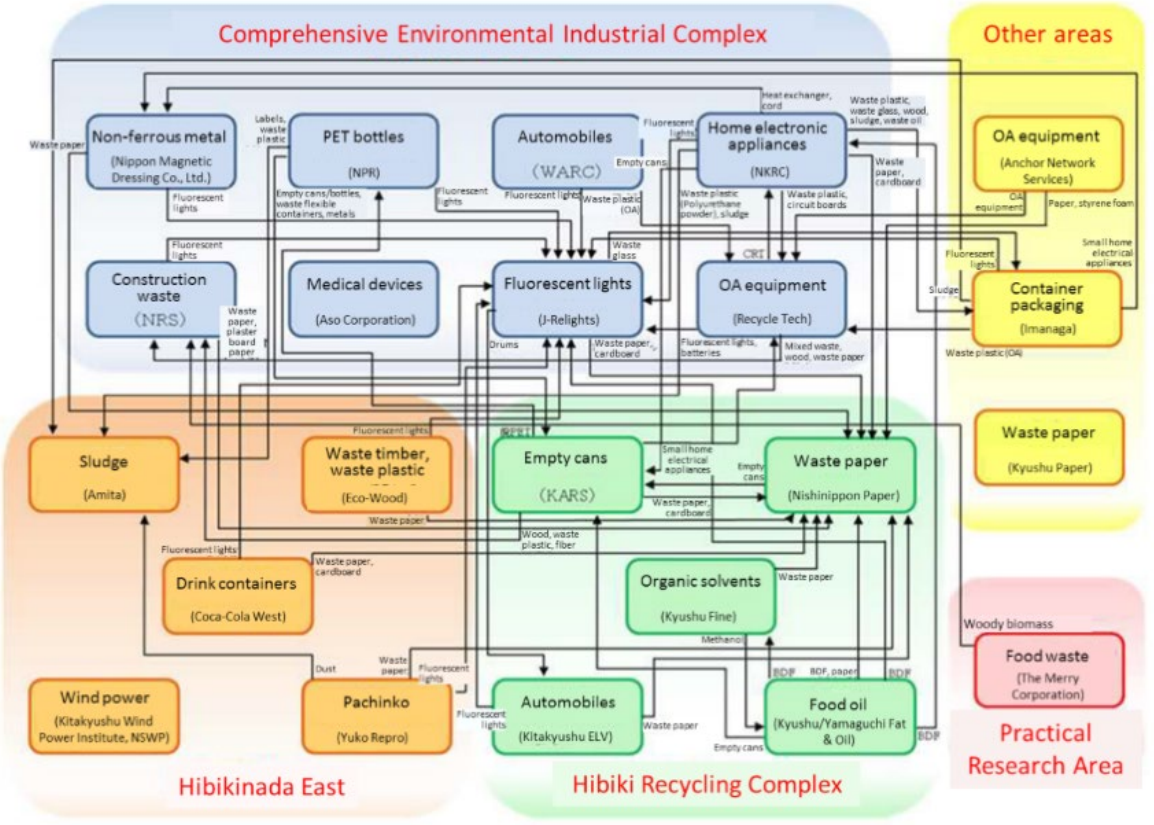
Effectiveness and efficiency

Effects of reducing greenhouse gas emissions

Kitakyushu city has carried out studies on the effects of reducing CO_2 emissions in Kitakyushu Eco-Town (effects from reducing impacts on the environment) every five years since 2005. In FY 2016, 433,000 tonnes of CO_2 emissions were reduced as a result of the business activities of tenant companies in Eco-Town (22 projects).[36] Looking at the breakdown, although 70,000 tonnes of CO_2 were emitted through the recycling process, the CO_2 reduction effect from recycling (503,000 tonnes) exceeds this figure significantly. These emission reductions have been made possible as a result of mutual collaboration among tenant companies. The effects from reducing emissions have grown each year from 304,000 tonnes (21 projects) in fiscal 2005 to 400,000 tonnes (22 projects) in fiscal 2010 and can be considered to have contributed to the low carbon development of Kitakyushu.

[35] Kitakyushu Eco-Town became the first area approved together with Gifu Prefecture, Iida City in Nagano Prefecture, and Kawasaki City in the first round of approvals in 1997.
[36] Kitakyushu City homepage. "Effects of reducing greenhouse gas emissions through the Kitakyushu Eco-Town Project"

Figure 28. Voluntary, mutual resource recycling between companies in Eco Town



Source: Japan Ministry of Environment (2018b)

Effects from promoting environmental industries

Overall, the number of tenants in Kitakyushu Eco-Town has been rising steadily since Nishinippon PET Recycling (NPR) started operations in July 1998, although there were minor ups and downs of the number of companies over the years, As of August 2018, 26 companies were developing 27 business activities employing 1,046 people. Of direct investment in Kitakyushu Eco-Town (total JPY 78 billion), only JPY 20.3 billion is from the government while the private sector invested more than three times the government investment. A large number of visitors from both Japan and abroad make their study visit to Kitakyushu Eco-Town. It amounts to about 100,000 visitors each year, or a cumulative total of 1.54 million to date (Japan Ministry of Environment, 2018a). It contributed to the inbound effect and promoted the name recognition of Kitakyushu City and the companies located here.

Features of Kitakyushu Eco-Town and implementation measures

Some of the distinguishing features of Kitakyushu Eco-Town include the (1) establishment of a social system to set up viable recycling businesses, (2) comprehensive development of basic research, technological development, and commercialisation, (3) acceptance of waste from wide-area, and (4) its role as a base for information disclosure and environmental learning. Although the private sector leads recycling businesses themselves, support from the government is indispensable for the development of systems to collect recycling resources, establish a sound market for recycled products, support the development of technologies

to cope with changes in waste disposal targets and needs of the times, and facilitate risk communication to gain understanding from residents. Kitakyushu City has appointed staff in the Environmental Bureau dedicated to provides one-stop services in collaboration with relevant departments within the administration.

Sustainability

Kitakyushu Eco-Town is a form of social infrastructure that advocates the city's goal of positioning itself as a "World Capital of Sustainable Development" and is promoted as the city policy. However, the continuity of business viability of tenant companies is dependent on social factors. Products that are on the market today may not exist in the future, and the businesses may not be viable, even with the best of technology if they fail to respond to social needs. It is also difficult to secure human resources. It is foreseeable that some markets may cease to exist, while new products to be recycled and new recycling technology may be required to respond to the new market needs. The tenant companies in Eco-Town themselves are also exploring to address such challenges while the local government is providing the necessary support to respond to requests by these companies. The sustainability of Eco-Towns may depend on continued metabolism, repeatedly replacing the old with the new. It is also indispensable to nurture the understanding of residents to ensure the continuity of the business. With the Eco-Town Center taking the lead, Eco-Town is actively disseminating information and promoting environmental learning, while tenant companies are required to open up their sites to the public, providing a sense of relief for residents. Kitakyushu City also provides support for publicity with the selection and exhibition of environmentally friendly products, technologies and industrial activities as "Kitakyushu Eco-Premium" at Eco-Town. Visits and sights of the f Eco-Town site and the recycled products contributed to raising awareness of residents on separating waste, creating a virtuous cycle.

Transferability

There are many local governments that are interested in Kitakyushu Eco-Town. Combined with Kitakyushu City's active engagement in international environmental cooperation activities, feasibility studies on Eco-Towns' construction are being carried out mostly in East and Southeast Asia. While it is natural that political support at the local level from national and local governments is needed, it is also necessary to create laws to boost recycling rates, improve residents' awareness on separating waste, develop collection systems for separated waste, concentrate technologies, find operators who accept recycled materials, and develop a market where these recycled materials can be used in order to establish recycling businesses themselves. To transfer the Eco-Towns experience to other municipalities, it is necessary to develop not only recycling technologies and environmental management know-how, but also include environmental education as a part of the package, to improve the awareness of companies and residents. With the limitations in administrative budgets, it is important that this be promoted by the private sector. As there are many cities that are concerned about an increase in the amount of waste and pressure on landfills along with the rapid economic development and urbanisation, demand for the transfer of recycling projects will continue in the future.

Conclusion

While Kitakyushu Eco-Town is a project that was originally launched with resource recycling and industrial promotion in mind, it is now evident it contributes to low carbon development through mutual collaboration between companies. With Kitakyushu Eco-Town positioned as a key project in the city's new growth strategy,

Kitakyushu City is engaged in the promotion of regional energy bases around the Hibikinada district. Of these projects, the promotion of low carbon development in the region is expected to be promoted through the enhanced application of solar panels and offshore wind power. Kitakyushu Eco-Town will continue to contribute to the creation of low carbon, sustainable city as a way to support such industries.

Republic of Korea

As described above, the government of the Republic of Korea provides robust support and incentives for local governments' climate action for a successful implementation of the local NDCs. Climate action at the local level is mostly taken up by the public sector, which covers wide-ranging sectors including buildings, transport, waste management, and renewable energy.

Gwangju Metropolitan City: ICT based Urban Carbon Management System

The Gwangju Metropolitan City, having 1.5 million population in 5 districts, signed the 'Agreement on the Climate Change Model City' with the Ministry of Environment in 2008, the first-ever agreement between the central government and the said local municipality.

Effectiveness and Efficiency

The Gwangju Ordinance of Climate Change Response and Gwangju Ordinance of Low Carbon Green Growth and Sustainable Development adopted in 2009 provides legal frameworks for climate change adaptation and mitigation at the municipal level. The implementation of plan and programmes is reviewed by the Citizen Council for Climate Change Response, which comprises about 30 experts and major stakeholder representatives. On the administration side, the Climate and Air Department in the Environment Ecology Bureau is in charge of ensuring effective implementation. Every year each department of the city government submits the implementation schedule of the climate action plan with an estimated emission reduction report from an individual project implemented. The individual project covers GHG Reduction, GHG Offset, Climate Change Adaptation and Green Lifestyle Promotion. The evaluation of project implementation is conducted twice a year by the Citizen Council, specifically examining the Performance Analysis of the estimated net GHG emissions offset compared to the analysis reported from the year. The estimation and analysis by each of 5 districts are supported by the local GHG inventory system.

Currently, Gwangju has a total of 74 low carbon initiatives including 55 GHG reduction projects covering Carbon Bank, Collective Energy, Electric Cars, NOx Reduction, LED, etc.; 6 Carbon offset projects affiliated with the Carbon Neutral Program on Environment Infrastructure, Emission Trade, Parks for carbon sink, etc.; 4 Climate change adaptation projects focusing on the Vulnerability in Forest, Monitoring on Illness, Prevention of Infection, etc.; and 9 Green Life projects in Low Carbon Apartments, Water saving, Local Food, Green Goods, etc. The budget allocation for the implementation of the abovementioned projects for five fiscal years from 2016 to 2020 totalled about 13 billion US dollars in 2018: 6.7 billion USD(Mitigation), 3.9 billion USD (Offset), 25 million USD (Adaptation), 37 million USD (Green Life).

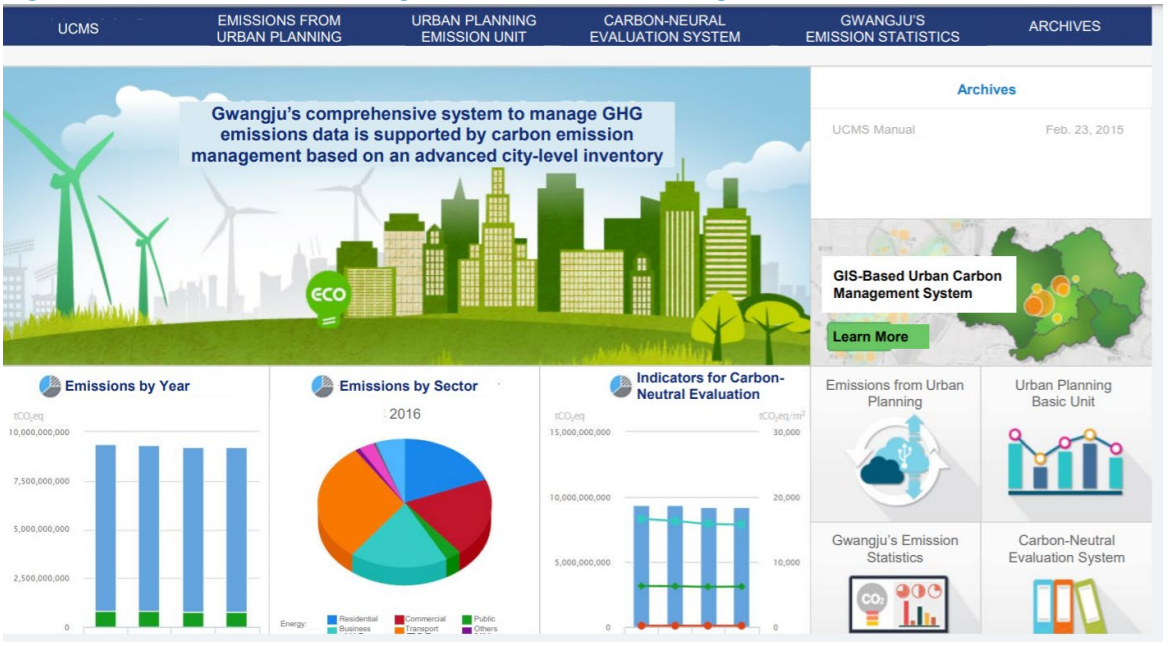
Sustainability

The climate change actions of Gwangju are supported by the ICT based online Urban Carbon Management System linked with the GHG Projection and Diagnostics (GPD) Program for monitoring, reporting, and verifying the effects of GHG emission and low carbon policies.

Pioneering low carbon policies and practices since 2010, Gwangju developed a GHG inventory tool named GHG Projection and Diagnostics Program (GPD), integrating sectoral inventory, emission parameters, emission calculation and estimation formula. The GPD aims to be the universal inventory system for the policy and programme based Clean Development Mechanism (CDM) projects

Subsequently, the GPD established an integrated GIS- based policy making tool named Urban Carbon Management System (UCMS) for municipal planning of buildings, urban transport, and green space infrastructure (Figure 29). UCMS allows the local government officers to adopt a science-based climate change policy development. Inventory categories are detailed to fit urban planning by lot and block. Emission resources and energy source are linked to the individual building information (with GIS spatial data). Sectoral emission factors and estimation algorithms are integrated into a city level carbon evaluation system.

Figure 29. Urban Carbon Management System of Gwangju



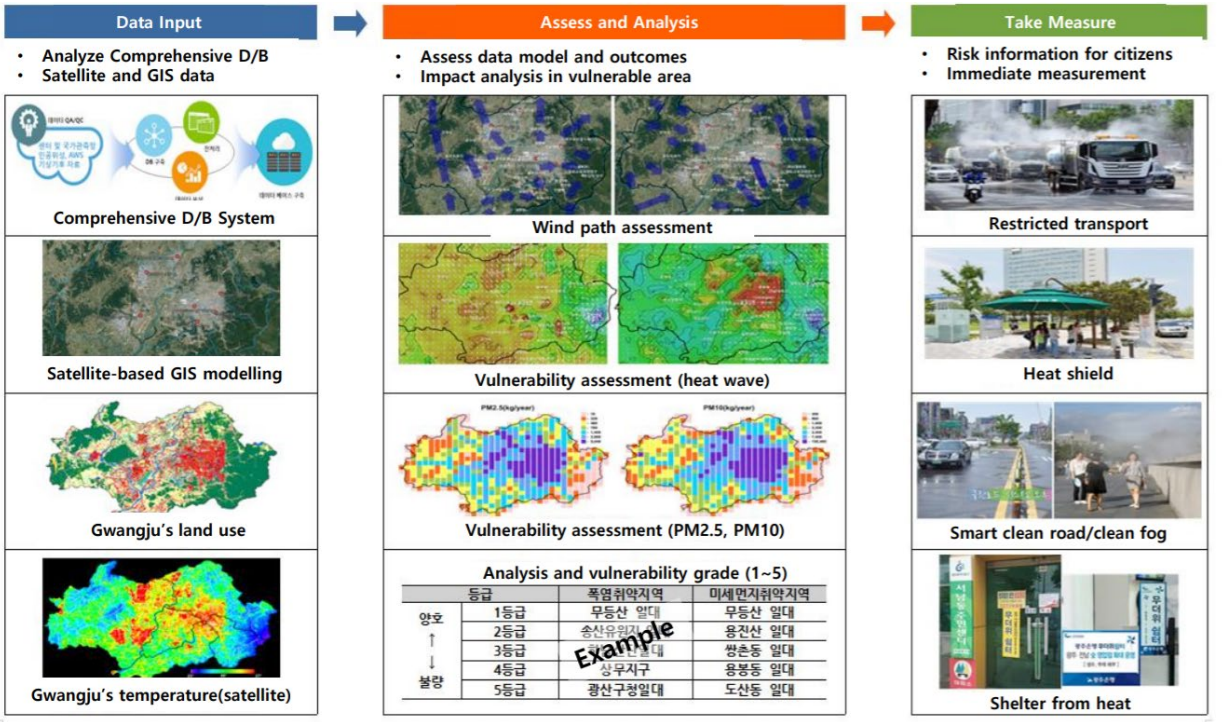
Source: Kang (2019)

Transferability

Providing GHG monitoring and evaluation tools for sectors related to building, transport and green area helps officers of districts and members in primary levels of administration to make policy decisions regarding carbon management projects under their management. The system contributes to the development of policies and initiatives specifically tailored to each city district with different socio-economic characteristics by providing relevant background information on the linkages between socio-economy, environment and climate change for policymaking process.

Currently, Gwangju is developing a local climate change and environmental impact assessment model to complete a comprehensive set of science-based tool for the development of climate change policy, covering climate change impact and vulnerability assessment, local GHG inventory in GPD, and integrated Urban Carbon Management System (Figure 30).

Figure 30. Use of Urban Carbon Management System in Gwangju Urban Carbon Planning



Source: Kang (2019)

Starting from the establishment of specialized policy supporting think-tank for climate change and environment, the International Climate and Environment Center (ICEC) in 2010, Gwangju has been promoting the dissemination of science-based carbon management tools for the member cities of the Urban Environment Accords (UEA), for which the city provides a secretariat service by organizing biennial mayors summit and implementing inter-city cooperation projects adopted by annual executive committee meeting of the UEA.

Jeju Province: Carbon Free Power System with Electric Vehicles, Renewable Energy, and Smart Grid

Jeju Special Self-Governing Province is one of the 9 provinces of the Republic of Korea with a total surface area of 1,850km^2 which encompasses 1.85% of the national territory. As of July 2019, 695 thousand people reside in the province.

The Jeju government has made numerous endeavours to make the island carbon-free by 2030.
Under the 'Carbon Free Island (CFI) 2030', Jeju set a target to cover 50% of energy consumption by 2020, and 100% by 2030 and making various and continuous efforts to supply renewable energy to the island.

Effectiveness and Efficiency

Jeju CFI plan is progressing in 3 directions: renewable energy, electric vehicles and smart grid, reducing GHGs emission and increasing energy efficiency. In order to establish efficient management of energy demand and economic and stable energy supply system, Jeju introduced basic energy ordinance of Jeju Special Self-Governing Province and developed its 5th Regional Energy Plan covering a period of 2018-2017 for the whole area of Jeju Special Self-Governing Province. The plan detailed the background, characteristics and applicable scope of the plan, trend and prospect of regional energy supply and demand, measures to secure and supply regional energy in a stable manner, present measures for setting eco-friendly energy supply such as new & renewable energy and its usage, measures to rationalize energy usage and reduce the emission of greenhouse gas, and legal, institutional, and administrative support measures and evaluation measures.
Renewable Energy Facility

Renewable energy
Starting with the operation of a 30 MW offshore wind power generation facility constructed in Hangyeong-myeon in September 2017, Jeju has issued the offshore wind power generation license of a 565 MW power generation facility in 3 district projects driven by the local government (Weoljeong-Hengwon, Handong-Pyeongdae, and Pyoseon) and 2 district projects (Daejeong and Hanrim) invested by private entities in 2017. In the onshore wind power sector, the 25.2 MW wind power facility was built at an onshore area in the Soomang district of Seogwipo city at the end of 2017 and 2 MW facility in the Dongbok district in 2018.

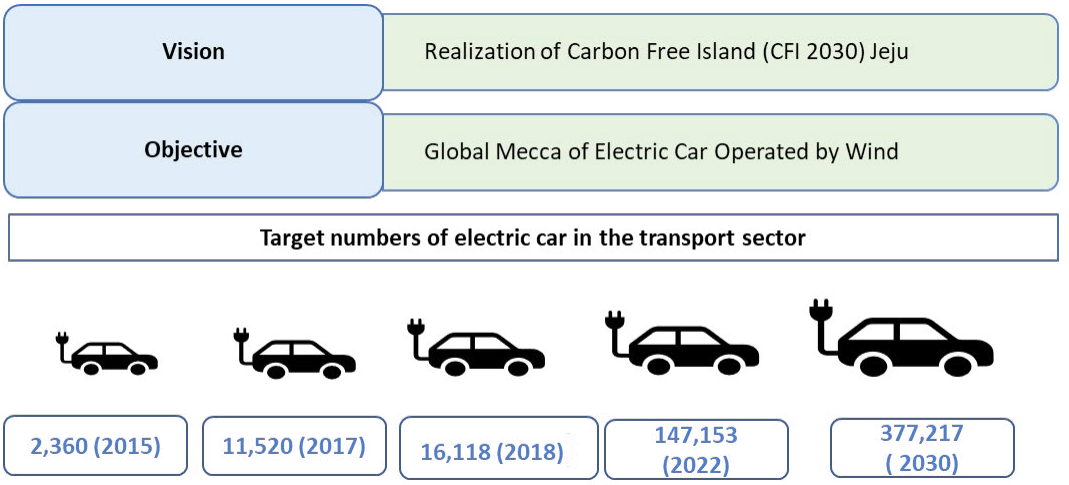
For solar power generation, the 47.5 MW facility work in 111 photovoltaic power generation sites was finished during 2016 and 2017. And the new 20 MW facility project was under preparation during the second half of 2017. To cope with the challenges prompted by the instability of the power grids from substantial renewable energy loads into the main grid, the government provided financial support to promote the installation of an energy storage system (ESS).

As a result, the share of wind and solar renewable energy in the power sector in Jeju increased from 5.00% in 2011 to 13.61% in 2017, which exceeded the national average of 8.07%. The total of new and renewable energy distribution amounted to 753GWh, including 55.2 MW of inland and offshore wind power turbine and 47.5MW of the solar power system. The total represented nearly 14% (5,385 GWh) of the island's total electricity use.

The plan has set a mid-term goal of new and renewable energy share in total energy use up to 50% by 2020. This target is anticipated to be achieved with an increase in the capacities of wind power systems by additional 565MW wind power and 20MW solar power system.

Electric Vehicles
The number of electric vehicles reached 11,287 as of June 2018, which accounts for 30.6% of the electric vehicles in the Republic of Korea, and 2.3% of all vehicles in Jeju. In 2030, all vehicles in Jeju (estimated 377,217 units) will be electric with island-wide charging infrastructure. Accompanied manufacturing and maintenance electric car services will be additional economic opportunities for Jeju (50,000 jobs by fostering and enhancing green industry).

Figure 31. Jeju Province: from World Environmental Hub to Carbon Free Island



Source: Kang (2019)

Smart Grid

Smart grid is one of the essential components of CFI implementation. Based on the testbed experience of Carbon Zero Smart Grid in Gujwa-eup district (2,000 households) for 2009~2013, the local government designed a Jeju smart grid master plan. Major energy and ICT companies including, KEPCO, LG Electronics, KT, and SK Telecom participated in this testbed project. The Smart grid master plan integrates various actors in the following fields: Smart consumers, Smart Transport, Smart power network including smart power transmission, digital substation, and advanced metering system. 49.1% of households (192,335 out of 391,623) have recently been connected to the Advanced Metering Infrastructure (AMI Smart Grid) in the power sector for efficient power supply and demand management(Figure 32).

Figure 32. Jeju Global Eco-Platform with Smart Grid

Source: Kang (2019)

For smart consumers, Jeju introduced the optimal management system that enables consumers and power suppliers to exchange power supply and demand information in real-time through the electric power network. The Outage Management System (OMS) includes the advanced metering infrastructure (AMI), energy management system (EMS), and two-way communication technology.

To provide grid infrastructure for smart transport, Jeju established a new business by conducting a series of demonstration projects aimed at developing advanced EV charging technologies for electric vehicles. The government financed the R&D programs to support the development of essential EV components which include the high-speed and low-speed charger, power network linkage technology (V2G), inverters and connectors. As a part of the new smart renewable energy solution, projects for improving efficiency and stability of energy storage equipment are introduced along with the preferential real-time fare system for new and renewable energy sources. The government has also provided substantial support in developing a microgrid technology, an energy-saving technology, an electric power quality compensation technology, and a power network linkage technology. Fundamental research promoted by the government focus on a wide scope of a smart power network including a smart power transmission, a digital power substation, and automation of distribution and management of irregular power supply and demand such as new & renewable energy and electric cars. The government has currently established infrastructures for 5 smart grid fields, verified 153 technologies, identified 9 business models, and promoted the commercialization of 6 business models.

As the results of CFI rolled out policies and investment, the share of renewable energy in Jeju rose from 5.00% in 2011 to 13.61% in 2017 (national average: 8.07%), and the number of electric vehicles reached 11,287 (accounting for 30.6% of the electric vehicles in entire nation, and 2.3% of entire vehicles in Jeju, as of June 2018). Also, AMI (Advanced Metering Infrastructure) is equipped in 49.1% of households (192,335 out of 391,623).

Despite vigorous efforts to optimize the CFI 2030 goals, a variety of challenges still await. Most of them come from its tourism-driven economy, for which it matters to build infrastructure for electric vehicles in a timely manner, make transition to low carbon tourism, establish solid legal infrastructure for low carbon society, and make closer collaboration scheme with central government, etc.

Suwon City - Living-Lab for Low Carbon Transport

Suwon has 121km^2 administration territory and 1.24 million citizens as of 2017. About 40km to the south of the capital city, its population continue to increase. Expanded urbanization is still going on to absorb the migration from the capital and surrounding semi-rural area.
In 2011, Suwon set its vision for a low carbon green city as ‘Environment Capital of Republic of Korea’, which was driven by the community based public participation in support of the evidence-based climate policy and measures.

Sustainability
In the implementation, Suwon launched a special committee on climate change and organized a series of town hall meetings to review different GHG reduction scenarios by 2030. The outcomes of expert meetings

and public consultations took the form of the 2030 GHG reduction target of 40% less than its historical emission level in 2005 (582.8 million tCO_2eq). As for the medium-term target, Suwon has adopted its target of a 20% cut from its historical emission in 2005, which limits its GHG emission around 466.2 million tCO_2eq.

A department of climate change response was established in 2012 and received a mandate to set up a series of policy programmes for climate change resilience. The department elaborated on the integrated GHG-energy management system and rolled out low carbon projects in energy conversion, efficiency, and energy-saving. The 58 low carbon projects in 9 sectors in Suwon started in 2012, which covered integrated GHGs management systems, the performance evaluation of individual projects and the verification of reduction outcomes. Based on these practical experiences, Suwon has developed a comprehensive climate action plan, including the detailed climate change adaptation plan as well as the comprehensive mitigation program (2014~2018). Suwon's experiences in low carbon climate-resilient sustainable development could be characterized by two factors, community-driven public participation of local climate actions and a panoply of the integrated GHG management policies and measures.

Effectiveness and Efficiency

The quantitative and indirect qualitative analysis of Suwon's implementation of low carbon policies in 2017 showed that 59% of the annual mitigation target was accomplished. The city had substantial difficulties in meeting its reduction target regarding a voluntary green lifestyle practice and a green transport system.

Table 9. Performance Evaluation of Suwon Low Carbon policies 2017

Category	Target	Reductions by Project			Achievement (%)
		Quantitative	Additional Reductions (Qualitative)	Total	
Total	643,827	333,327	47,556	380,883	59.2%
Green living practices	220,183	11,147	36,656	47,803	21.7%
Green transport system	146,371	15,740	-	15,740	10.8%
Expansion of Green Areas	96,447	96,709		96,709	100.3%
Energy Efficiency	10,965	10,509		10,509	95.8%
Renewable Energy	7,496	6,254		6,254	83.4%
Eco Friendly Buildings	94,114	107,340		107,340	114.1%
Efficient Resource Use	68,251	85,628	10,901	96,528	141.4%

Even if the Suwon's experience resulted in limited mitigation outcomes at the moment, the key characteristics of Suwon's decarbonization policies can be categorized into the following 4 points:

i) Suwon set up a local GHG reduction target higher than the national target and established a phase-by-phase evaluation/verification system to monitor the achievement of reduction projects.

ii) The GHG reduction target in the local energy plan was implemented through wide participation of civil societies and citizens, which facilitated further collaboration among major stakeholders

iii) including the city government, industry and business groups, thus transition to the low carbon energy paradigm of the city.

iv) Suwon experimented with several living-lab type public participation projects. 'EcoMobility Suwon 2013' was held for a month (details in the next subsection), and its success led to the beginning of the realization of a green traffic system for the decarbonization of the city.

v) With the different form of civil support, Suwon reduced its GHG emission by 1.1 million tons in cumulative terms for the first 3 years of implementation of its comprehensive low carbon plan: civil campaign, a model city for environmental education, a hands-on exhibition for climate change education, etc.

Suwon's pioneering decarbonization policies always undergo the internal and external civil consensus-building process to ensure the transparency and responsibility of the project implementation and ownership by citizens. In this regard, assuring environment welfare and energy equity was also highly appreciated for the vulnerable cluster of people. The 'Solar power-sharing project was promoted as one of the practical model cases connecting renewable energy with energy welfare.

Living-Lab for Low Carbon Transport: 'EcoMobility Suwon 2013'

As a part of the 'EcoMobility Suwon 2013' program, Suwon city designated one of its sub-districts of 4,300 permanent residents as an automobile free zone for a month (1-30 September 2013) and experimented with carbon-free and low carbon transportation equipment (bicycles, light electric vehicles, etc). It was the first-ever sub-district level living lab for sustainable eco-mobility policy experimentation in real urban transport system (Figure 33). The programme was designed and developed by Suwon city, ICLEI, UNHABITAT and Kores Environment Institute.

Figure 33. Eco-mobility Living Lab Suwon 2013

Source: Kang (2019)

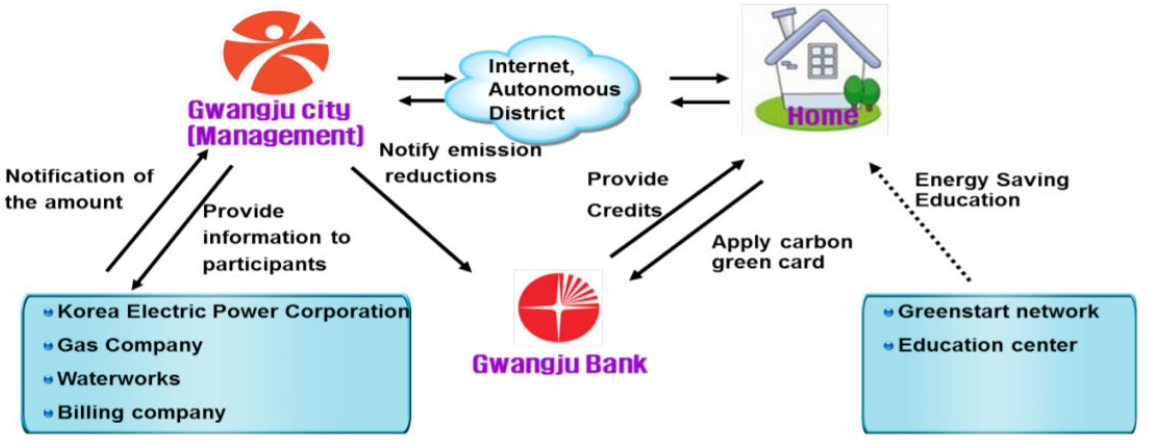
During one month of the living lab, the city government, the resident representatives, public research institutes and civil society organizations organized several consultation meetings for monitoring and assessing the potential and enabling conditions of eco-mobility on a real-life scale. More than 1,500 private cars were kept parked for the duration of the whole month, and the internal traffic was managed by 6 lines of electric buses that ran every 15 minutes. The local administration also provided the 24 hours emergency traffic services with electric shuttles always set ready to accommodate the urgent needs of the local residents. The city government collaborated with transport-related businesses to ensure that the sub-district residents commute to work outside the Eco-mobility zone. The city administration also provided 400 units of individual mobility tools like bicycles, electric motors, etc. Post services and police stations also used electric vehicles and light cargos. Throughout the project duration, the city observed a 2.3% reduction in car use and a staggering 16.3% increase in walking and an 8.4% in bicycling. The city also witnessed carbon emissions from vehicles decreased by 21.1% (108.89 tons out of 516.34 tons). A total monthly reduction of 20.65 tons of CO_2 is anticipated if 4% of car commuters switch to emission-free mobility options.

The challenges mentioned by residents and visitors were readily taken into consideration to find pragmatic solutions. The results proved the important potential of community-driven green traffic system at both sub-district and district levels and the lessons learned from the program provides valuable inputs on the formulation of long-term goals for climate-resilient and eco-friendly development of Suwon. If 38% of the residents voluntarily display their persistent efforts in adopting Ecomobility, the estimated total of 1,306.68 tons of CO_2 will be reduced annually. Such a projected reduction in CO_2 is equivalent to planting 470,405 plants. If the program expands across the entire Suwon city, a drastic cut in emissions is forecasted. Suwon's experiment is still ongoing to change the city's energy paradigm through further collaboration with the city government and energy industries.

Gwangju Metropolitan City - Financial Incentives for Low Carbon Lifestyle

Gwangju actively promoted demand-side carbon reduction policy encouraging low carbon lifestyle. Systematic education and citizen-led policy campaigns bring enhanced public awareness and participation. In collaboration with the Ministry of Environment, Gwangju introduced its very first Carbon Bank Program in 2008, which promoted low carbon consumption habits by granting the participants carbon points that have a monetary value.

Figure 34. Carbon Banking System in Gwangju



Source: Kang (2019)

Effectiveness and Efficiency

A household subscription to the carbon credit system, submitted to the district office of resident, is listed on the registry of carbon credits system managed by the city administration. The city government send the registry notice to the electricity, water and gas providers as well as to the commercial bank, which issues a carbon point integrated credit card to the household subscriber. Every year, the electricity, water and gas providers monitor the net saving of electricity, water and gas consumption of the subscriber compared to the previous year consumption records, and then report the results to the city administration. After receiving the notice of the saved amount of electricity, water and gas bills, the contracted bank gives a part of the saved bill to the subscriber as carbon points, which the subscribing households can use for shopping (Figure 34).

As of 2018, approximately 350,000 out of the total 580,000 Gwangju households have registered for the Carbon Bank System, ranking first amongst all metropolitan cities in the Republic of Korea for its subscription rate exceedingly over 50%. In early 2016, 48,000 homes attributed to reducing 55,000 tons of GHG emissions and received 300 million won worth of green points in return for their contributions towards sustainable livelihoods. The reduction of such staggering amounts of GHGs generated an equivalent effect of planting about 20.91 million pine trees. The city has assigned carbon coordinators to strategically assist households to achieve further energy reductions. Since 2014, the Gwangju Metropolitan government stimulated the participation of 27 major GHG-emitting facilities in lowering their carbon footprints by granting merit-based awards along with financial incentives. Although the Carbon

Bank System was primarily applicable only to individual households, the system has now been expanded to include non-residential, and private buildings. Up to now, in Gwangju, a total of 351,576 entities participated in the system including individual households (84,001), apartments (266,804), commercial facilities (514) and the public sectors (257).

Sustainability and Transferability

Based on the experiment of the Gwangju carbon credit system, the Ministry of Environment set a nationwide carbon credit system in 2014, which has a key role in GHG reduction at an individual household level. If a household managed to save 5~10% of their bill, its carbon credit point is equivalent to 155~17,500 Korean Won. If a household's bill saving goes beyond 10%, maximum carbon credit could go up to 70,000 Korean Won.

The nationwide expansion of the system has enabled many cities in different provinces such as Jeonju, Gumi, Jinju etc., to take bold initiatives in reducing their shares of GHG emissions. Gwangju is also reviewing the enactment of incentive plans for environmentally conscious drivers who travel less than the designated miles daily. Regardless of the steadily increasing number of participating populations, there are still significant numbers of people unaware of the system's existence. The active engagement of residents is vital to yield systematic and accurate data on GHG emissions reduction trends. Gwangju should also ensure the visibility of the reduction in GHG emissions. Nevertheless, it is an undeniable fact that the Carbon Bank system has constructed a fundamental mechanism for the Korean Ministry of Environment to spread the carbon point system both domestically and overseas. The system is being acknowledged to serve as an excellent exemplary guide for a low carbon policy which all environmentally conscious nations should put into practice.

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North-East Asian Subregional Programme for Environmental Cooperation (NEASPEC)

NEASPEC is a comprehensive intergovernmental cooperation framework, established in 1993 by six member States, namely, China, Democratic People's Republic of Korea, Japan, Mongolia, Republic of Korea, and the Russian Federation. Senior Officials Meeting (SOM) is held annually as the governing body and principal vehicle for the evolution of NEASPEC. United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) East and North-East Asia (ENEA) Office functions as the NEASPEC Secretariat.

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