NEASPEC NEA-LCCP

COMPARATIVE STUDY ON LOW CARBON CITY DEVELOPMENT IN CHINA, JAPAN AND THE REPUBLIC OF KOREA

SUMMARY REPORT

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INTRODUCTION

This report analyzes and compares the low carbon city 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 and describes specific instances of carbon reduction actions in cities and in sectors in fifteen brief case studies. This report will be used in NEA-LCCP information-sharing activities and to promote regional low carbon cooperation.

Section One, Background provides a general survey of global and regional trends low carbon city policy. It also describes the driving factors of greenhouse gas emissions in China, Japan and Republic of Korea. Section Two, Low Carbon City Policy in China, Japan and Republic of Korea, reviews low carbon policy in the three countries. It includes discussion of low carbon policy overall but focuses on low carbon city policy and its respective institutional frameworks in each country. Section Three, Comparative Analysis of Low Carbon City Policy, examines the similarities and differences in the low carbon city policies of China, Japan and Republic of Korea. Section Four, Good Practices, contains fifteen case studies of low carbon city policy at both the municipal and project levels that may be instructive to cities in Northeast Asia broadly. Section Five, Challenges and Recommendations, describes policy challenges common to all three countries in this study, challenges in the low carbon city policies of each country individually, and offers recommendations for new sub-regional actions.

Carbon Emission Driving Factors in China, Japan and Republic of Korea

A. Carbon Emissions

China surpassed the United States as the world's biggest carbon dioxide emitter in 2007. It currently accounts for approximately 27 percent of global emissions. Emissions rapidly increased from 2001 to 2013, the period after which China joined the World Trade Organization and manufacturing greatly expanded. Emissions dropped slightly from 2014-2016. China's emissions per capita are higher than the per capita average for world, but not as high as Japan's or Republic of Korea. However, per capita emissions in some Chinese cities are equal to or higher than cities in developed countries.

In recent years, China's emissions intensity has dropped at a faster pace than originally planned. There was a significant improvement in carbon emissions intensity per unit of GDP during the 12th FYP period, with a reduction of 20% from 2010, higher than the planned target of 17%, and China reached its 2020 carbon intensity emission target of reducing carbon emissions intensity by 40%-50% from 2005 in 2017, three years ahead of schedule.

In Japan, emissions have increased year after year since 2009, when emissions were at their lowest, although they started to decline again from 2013. Increases in emissions between 2011 and 2013 are related to the Great East Japan Earthquake of 2011. As a result of the impacts from the earthquake and subsequent disasters, the operating rate for nuclear power generation facilities has fallen significantly. This demand has been filled by an increase in thermal power generation, which has caused the

consumption of fossil fuels to increase and is the main reason for the rise in emissions. As a result of the earthquake disaster, the operating rate for nuclear power generation facilities fell from 67.3% in 2010 to 23.7% in 2011 and to 0% by 2014 (Japan Ministry of Environment, 2019).

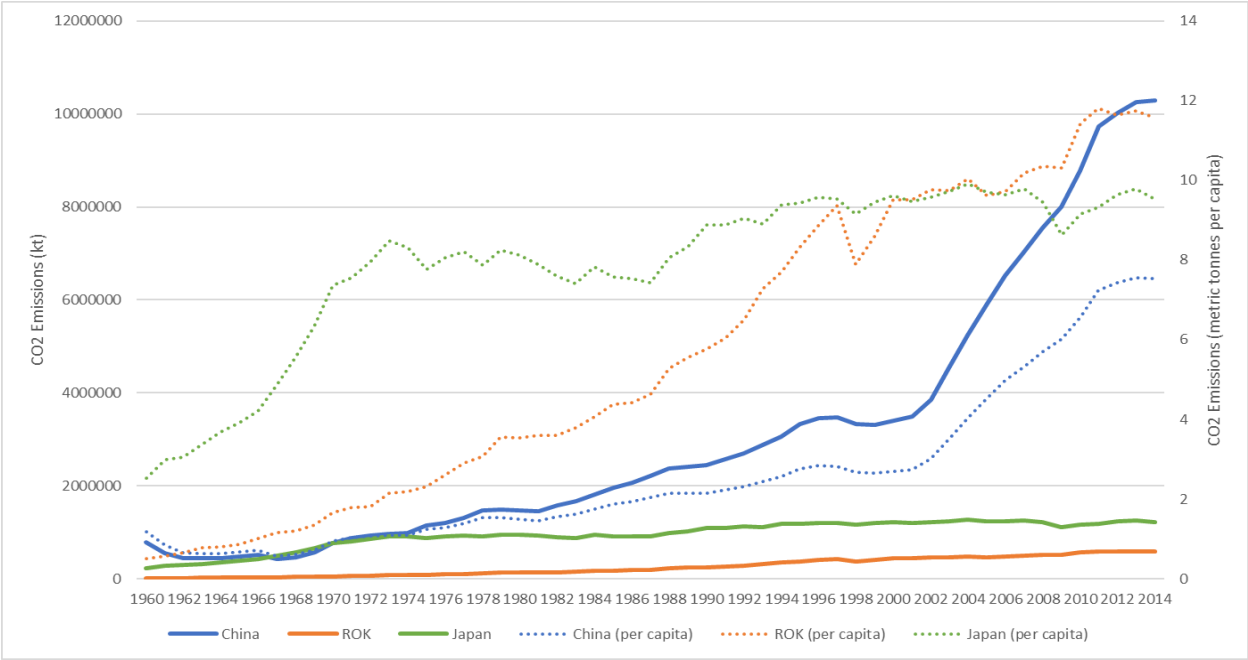

Figure 1: CO_2 Emissions and CO_2 Emissions per Capita for China, Japan, and Republic of Korea 1960-2014 (World Bank, 2019)

Emissions started to decline from 2014 due to a decrease in electric power consumption, with the power conservation measures carried out in the East Japan area playing a major role. Another factor contributing to this decline is improvements to emission factors for electric power (increased introduction of renewable energy, fuel conversion and high efficiency measures in thermal power generation, etc.) (Japan Ministry of Environment, 2014).

In **the Republic of Korea**, total GHG emissions in 2016 showed an increase of 136.9% from 1990. Emissions increased 0.2% from 2015, however, showing a leveling off of the emissions growth rate. National emissions increased annually by around 8% from 1990 to 1997. After a brief interlude of decreasing emissions due to the Asian financial crisis of 1997-1998, the trend of increasing emissions slowed down in the early 2010's. The annual emissions growth rate has stabilized at around 0.2~0.3% since 2014.

Republic of Korea's energy sector represented 87.1% of national emissions in 2016, an increase of 150.5% from 1990 level. Economic growth led by energy intensive industrialization, electricity and transportation demand rise are the main drivers of national emissions. Recent stabilization of the national emission growth rate is being driven by the slowdown of the Republic of Korea economy, which in recent years has had an annual growth rate of less than 3%.

B. Demographics

The share of **China's urban population** increased from 42.99% in 2005 to 58.52% in 2017, with an average growth rate of 1.29%. In 2011, China's urban population size surpassed its rural population size. Because urban energy consumption is consistently higher than rural energy consumption, China's continuing urbanization is expected to drive up carbon emissions. The dependency ratio of China's elderly population (aged 65+) increased by almost 4% between 2005 and 2017, while the size of the working population (aged 15-64) peaked in 2011 and has since begun to decline. At this juncture, the impact of these age structure changes on carbon emissions is not clear. Typically, working urban people have higher energy consumption, with commensurate carbon emissions. However, this could be offset by the lower energy consumption habits of a growing elderly population, who tend to be more sedentary, thereby bringing down their carbon footprint.

The overall population of Japan doubled over a 100-year period, from a 1920 base year population of around 56 million. However, the population peaked in 2010 at 128 million, after which it has continued to decline. Japan is experiencing declining birthrates and an aging population. When Japan's population is divided into three groups (14 and under, 15-64, and 65 and older), the population aged 65 and older has increased from 10% over the past 30 years to 26%, and in 2007, it overtook the proportion of the population aged 14 and under. Meanwhile, the proportion of the population aged 15 and under decreased from 22% to around 13%. The urbanization rate in Japan passed 90% in 2009. Compared to developing countries, Japan's potential for urbanization is limited.

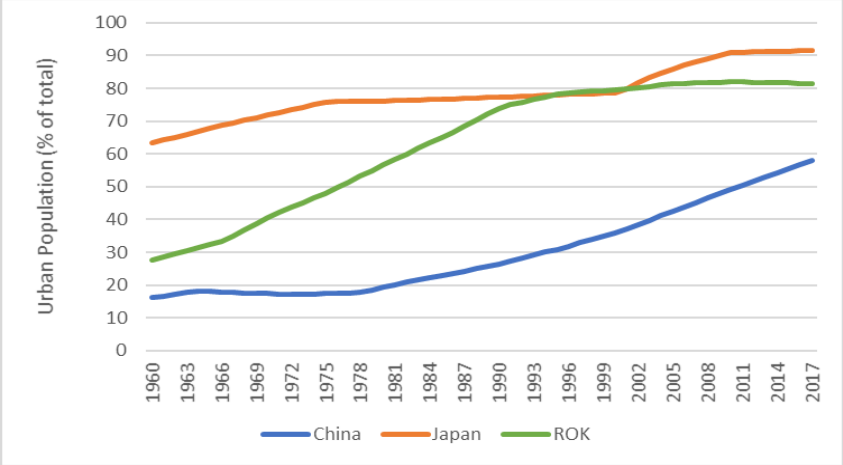

Figure 2: Urban population percentages in China, Japan, and Republic of Korea (World Bank, 2019)

The **population of Republic of Korea** doubled over the last sixty-year period, from around 25 million in 1960 to approximately 51.5 million people today. In 2016, the annual population growth showed a 0.45% increase from 2015. This shows that the emissions-driving effect from population growth is not as great as other factors (e.g. economic growth driven by the expansion of international trade in energy intensive manufactured goods). The share of the population aged over 65 years represented about 13.4% of the total population in 2016, which was almost four times higher than that of 1960 (3.4%). As in Japan, declining birthrates and population growth (from 2.91% in 1960 to 0.45% in 2016) together with an aging population have become policy challenges. In 2015, more than 81.5% of the total population lived in urban areas, and less that one fifth of the total population resided in semi-urban and rural areas. The urban population in 2015 was 41.7 million, almost six times higher than in 1960.

C. Energy Structure and Consumption Patterns

China's energy consumption has been steadily increasing but its energy mix is getting cleaner. Total energy consumption almost doubled between 2005 and 2016. During this period, the share of coal in primary energy dropped by around 10% and the share of non-fossil fuel increased by almost 5%. Currently, China is undergoing the largest build out of wind power, hydropower, solar PV and nuclear power. Non-fossil fuel installed capacity accounted for 35% of total installed capacity in 2015.

China's industry sector is the largest consumer of energy. However, this share has been decreasing, dropping from 67.5% in 2010 to 60.3% in 2015. China's industrial structure is gradually shifting from being energy-and resources-intensive to possessing high productivity and incorporating high technology. China's transportation energy consumption is low relative to developed economies. However, mobility and freight activity are rapidly increasing due to rising living standards, continued industrialization, and ongoing urbanization. Transport's share of final energy consumption was 15.3% in 2015, up from 13.3% on 2010. China's residential and commercial buildings accounted for around 21% of total final energy consumption in 2015, a growth of 6% from 2010. This is driven by urbanization and growing commercial and personal income. The "locking in" of high-carbon land use patterns is a common phenomenon. High-carbon land use is characterized by superblocks and single-use development.

Energy demand in Japan has rapidly increased since the 1960s, growing over three times in half a century. Japan's degree of dependence on oil reached 75.5% of domestic supply of primary energy in 1973. However, since the oil shock of 1973, Japan has sought to reduce its dependence on oil by promoting the introduction of nuclear power, natural gas, and coal. The share of oil in domestic primary energy supply dropped sharply to 40.3% in fiscal 2010 with an increase in the proportion of alternatives such as coal (22.7%), natural gas (18.2%), and nuclear power (11.2%). However, with the Great East Japan Earthquake in 2011 and the subsequent shutdown of nuclear power plants in the country, the proportion of fossil fuels increased and the proportion of oil that had been moving on a downward trend in recent years rose to 44.5% in fiscal year 2012 (Japan Ministry of Economy, Trade, and Industry, 2018). . Between 1965 and 2016, the business sector ranked highest in energy consumption with a 6.37-time increase, followed by the residential sector at 4.28 times and the transport sector at 3.92 times. Growth in the industrial sector has been the lowest, stalling at only 2.07 times. 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 these sectors (Japan Ministry of Economy, Trade, and Industry, 2018).

Energy demand in the Republic of Korea increased rapidly between 1981 and 1997, before the Asian financial crisis, led by a large demand for oil. After the crisis, natural gas and renewable energy consumption rose more rapidly than oil and coal. Total energy consumption in 2016 was 225.2 million TOE, of which oil represented 50.8% with 114.3 million TOE. Coal represented 32.3 million TOE, followed by natural gas with 22.2 million TOE. The annual energy demand growth rate in 2016 was 3%, with a decreasing growth rate trend in the last 35 years. Domestic primary energy production amounted to 50.1 million TOE and imported primary energy was about 321.9 million TOE in 2016. The industry and transportation sectors led final energy consumption growth between 2001 and 2017. In 2016, industry consumed 61.2% of total primary energy consumption. This was followed by transportation at 18.8%, the residential sector at 9.6% of total primary energy consumption, and the public sector at 7.6%.

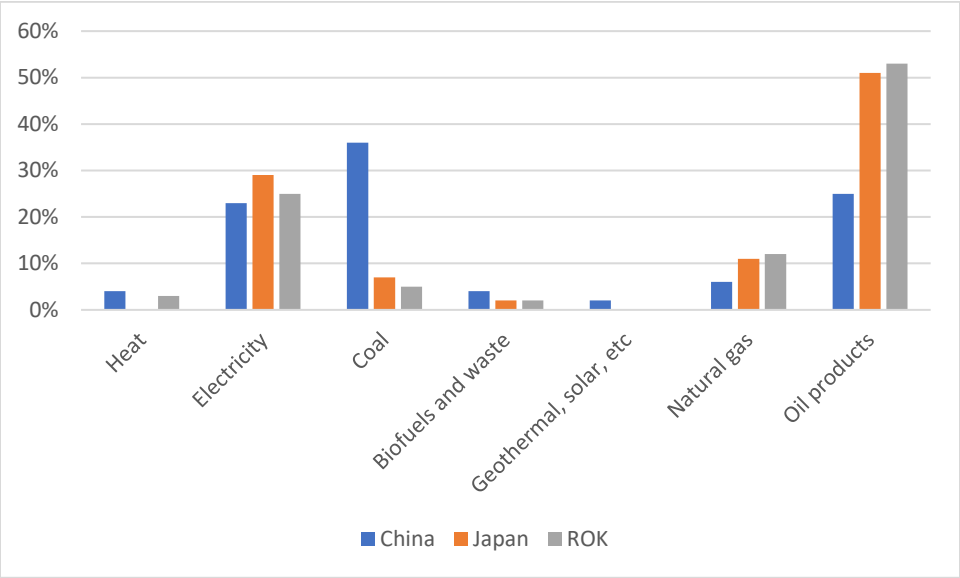

Figure 3: Total Final Consumption by source in ktoe (IEA, 2019)

Low Carbon Policy in China, Japan and Republic of Korea

A. National Low Carbon Policies and Targets

China

The Five-Year Plans (FYP)s are at the core of China's economic and development strategy and have a major impact on low carbon development efforts. They contain both binding and non-binding targets across a range of measures, including carbon emissions and energy use. Supporting the specific low carbon targets, such as those embodied in the NDC, China has developed a range of plans such as the "National Climate Change Plan (2014-2020)", "Work Plan of Controlling Greenhouse Gas Emissions for the 12th FYP" and "Work Plan of Controlling Greenhouse Gas Emissions for the 13th FYP". These documents outline major tasks and sector-specific measures for low carbon development. Currently, China is in the process of developing its 14th FYP, which will run from 2021-2025.

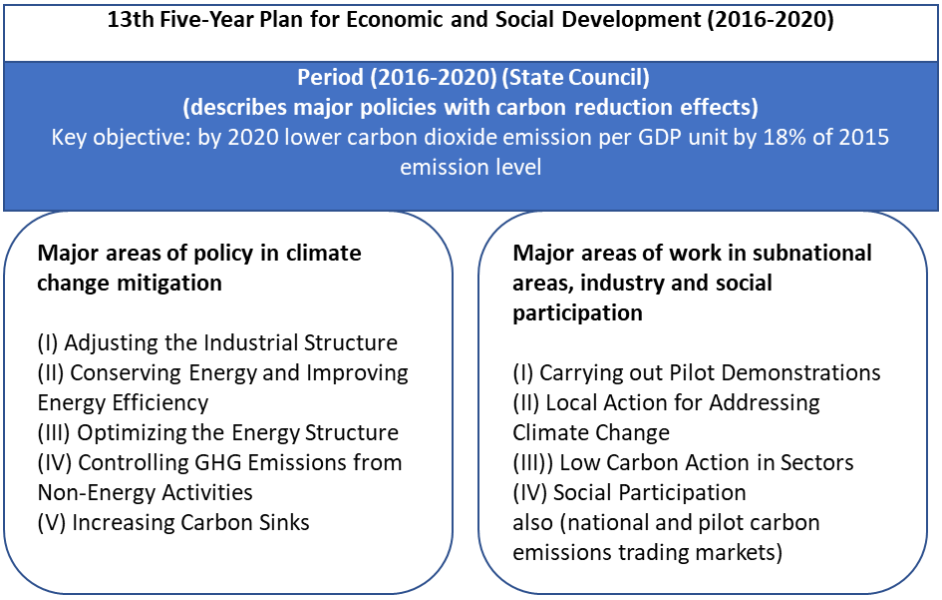

Figure 4: Framework for global warming countermeasures in China

China has a Target Responsibility System (TRS) policy implementation mechanism that assigns national targets to local government and requires the latter to be responsible for achieving the assigned target. Currently there are two legally binding targets that relate to climate change and low carbon development in China's FYP. One is an energy intensity reduction target, and the other is a carbon intensity reduction target. 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.

China has also instituted economic incentives for low carbon development. To implement its carbon and energy intensity targets and sector-specific policies, the central government offers subsidies, tax breaks, and special funds. Apart from these, the development of the emissions trading scheme (ETS) is a major market-based feature of China's low carbon strategy. China's ETS that been operating as a regional pilot program since 2013, covering five cities and two provinces. The pilots have generated know-how for the design and implementation of China's national ETS, which was launched in 2017 and is expected to begin fully operating with emissions trading in 2020.

Japan

Japan enacted the "Act on Promotion of Global Warming Countermeasures" (Global Warming Act) in 1998. The Global Warming Act has been positioned as 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.

According to the "Plan for Global Warming Countermeasures" decided by the Cabinet in 2016, the Japanese government has introduced various policy packages, including voluntary methods, regulatory methods, economic methods, and information methods. These policies include 66 policy areas broken down into five sectors: (1) GHG emission reduction policies and measures, (2) development of civic movements, (3) measures taken by municipalities, (4) measures expected to be taken by businesses with particularly high levels of emissions, and (5) promoting the reduction of GHG emissions overseas, securing international collaborative opportunities, and promoting international cooperation (Figure 5).

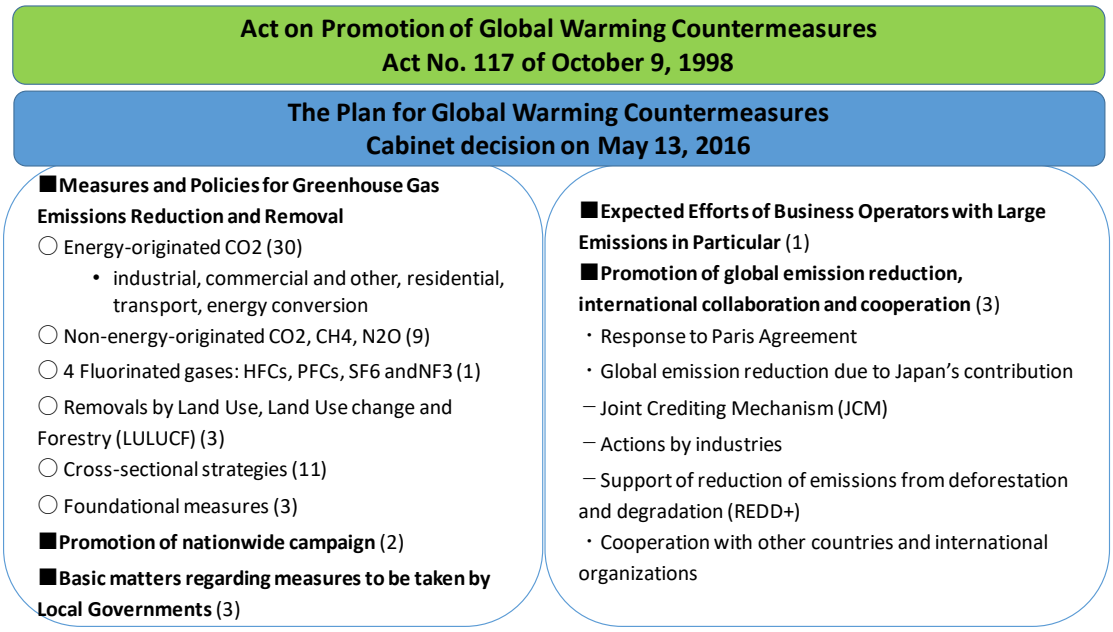

Figure 5: Framework for global warming countermeasures in Japan

Note: Numbers in brackets show the number of policy areas.

Source: Cabinet Decision. "The Plan for Global Warming Countermeasures", 2016

Republic of Korea

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 sets out nine principles that guide Republic of Koreas approach to low carbon development. Building on this, a sectoral emission roadmap was announced in July 2018 together with the "Renewable Energy 2030" implementation plan, which aims to increase the weight of renewable energy in the power sector from 7% to 20% by 2030. Republic of Korea also operates a mandatory, nation-wide ETS, which was launched in 2015. It was the first of its kind in Asia, covering 591 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).

B. Institutional Frameworks and Governance Structures

China

In 2007, the State Council, China's highest government authority, set up the National Leading Group on Climate Change, Energy Saving and Pollution Reduction. This group has ministers or vice-ministers from more than 20 ministries or commissions as members, is headed by the Premier, and housed in the National Development and Reform Commission (NDRC) (Government of China, 2007). In 2008, the NDRC established the Department of Climate Change (DCC), which is the key government agency for low carbon development and in charge of developing and implementing climate change policies. As illustrated in Figure 5, the DCC was transferred from the NDRC to the Ministry of Ecological Environment (MEE) during the government restructuring of 2018. MEE and NDRC now are working together to run the daily work of the national leading group (Government of China, 2018), with MEE coordinating actions and policies that address air pollution and climate change.

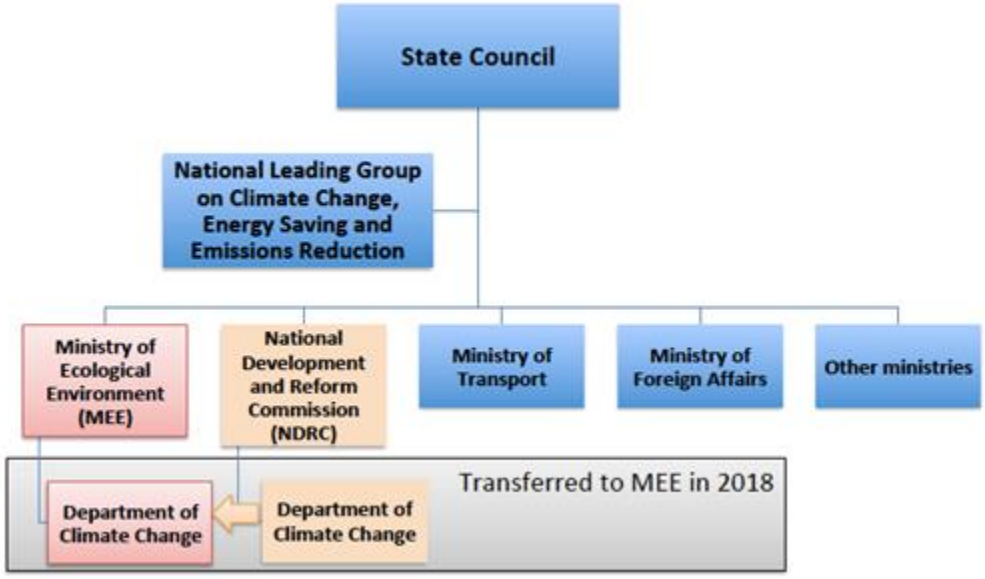

Figure 6: China's National Environmental Policy Administrative Structure

At each level of government, the provincial governor or mayor's office can issue orders and manage the work of government agencies within its jurisdiction. Therefore, local EEBs report to both local governments and higher-level EEBs. When priorities are in conflict, local interests are prioritized over functional interests, as the local government has a greater say on resources allocation after China's system of fiscal decentralization. Within this structure, local governments have the power and flexibility to develop and implement policies that serve local priorities. This makes it possible for them to explore unique, locally appropriate low carbon actions.

Japan

The Ministry of the Environment (MoE) is the primary organ dealing with issues of environment and sustainability, including coordinating the state apparatus for environmental protection and enacting general environmental policies including for general pollution control and nature conservation. However, environmental policymaking is a collaborative process involving several other Ministries and supporting bodies. Perhaps most important is the Ministry of International Trade and Industry (MITI), which together with the MoE is heavily involved in addressing Japan's industrial pollution (Ren, 2000).

A key governance dynamic in the development of low carbon policy is collaboration with industry. Rather than imposing strict regulations on industry, the policy approach in Japan has been one of close collaboration and negotiated agreements with industry to help them set their own sectoral targets for emissions reductions and other metrics of environmental performance (OECD, 2010). Formal, multi-stakeholder advisory groups called Shingikai (審議会) provide policy recommendations to the bureaucracy and Ministers while also serving as a venue for coordination and negotiation among the various interest groups. In the case of climate policy, and Japan's NDC development, MITI and MoE actively consulted three of their Shingikai, the Industrial Structure Council, the Advisory Committee for Natural Resources and Energy, and the Central Environmental Council (see Figure 7).

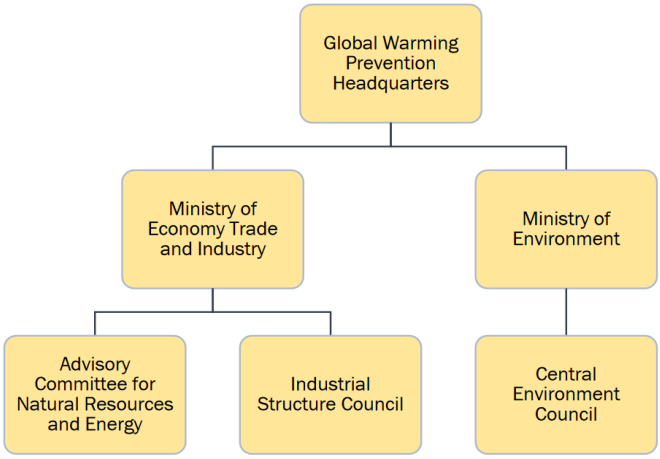

Figure 7: Administrative structure of Japan's climate policymaking (Sofer, 2016)

Republic of Korea

The Ministry of Environment, which exists under the office of the Prime Minister, is the primary body responsible for environmental protection and regulation. In 2008, the Republic of Korea Meteorological Administration became a subsidiary of the Ministry to facilitate countermeasures against climate change. However, there are also environmental matters scattered across the work of and laws enforced by other ministries, which can in some cases lead to duplication and unclear responsibilities (Seol & Kim, 2018). Another key structural feature in relation to low carbon development is the Presidential Committee on Green Growth, which is in charge of developing the National Strategy for Low Carbon, Green Growth (KEI, 2019). This includes reviewing the national five-year plans for low carbon, green growth. The Committee comprises public officials and up to 50 experts commissioned by the president. It is co-chaired by the Prime Minister and a commissioned expert and as of 2011 included the Ministers of Strategy and Finance;

Knowledge Economy; Environment; and Land, Transport and Maritime Affairs. The committee plays an important role in coordinating national and local low carbon development efforts. To help align with it, city and provincial governments also have local committees on green growth that fall under mayoral/gubernatorial supervision (UNESCAP, n.d.).

C. Low Carbon City Policies and Actions

China

As shown in Figure 9, a low carbon pilot city organizes a leading group for municipal low carbon development with the mayor as the group leader and directors of key governmental agencies as group members. Up to last year, as climate change and low carbon policy issues are handled by the NDRC at the national level, they are also managed by the municipal development and reform commissions (DRC) at the local level. DRC's have also managed the daily work of the local leading group for low carbon development. After the latest government reshuffle, it is now municipal EEBs that are in charge of climate policy at the city level. While the final impacts of the government reshuffle at the local level remain to be seen, the EEB is likely to inherit the daily work of the low carbon leading group in the LCCPs.

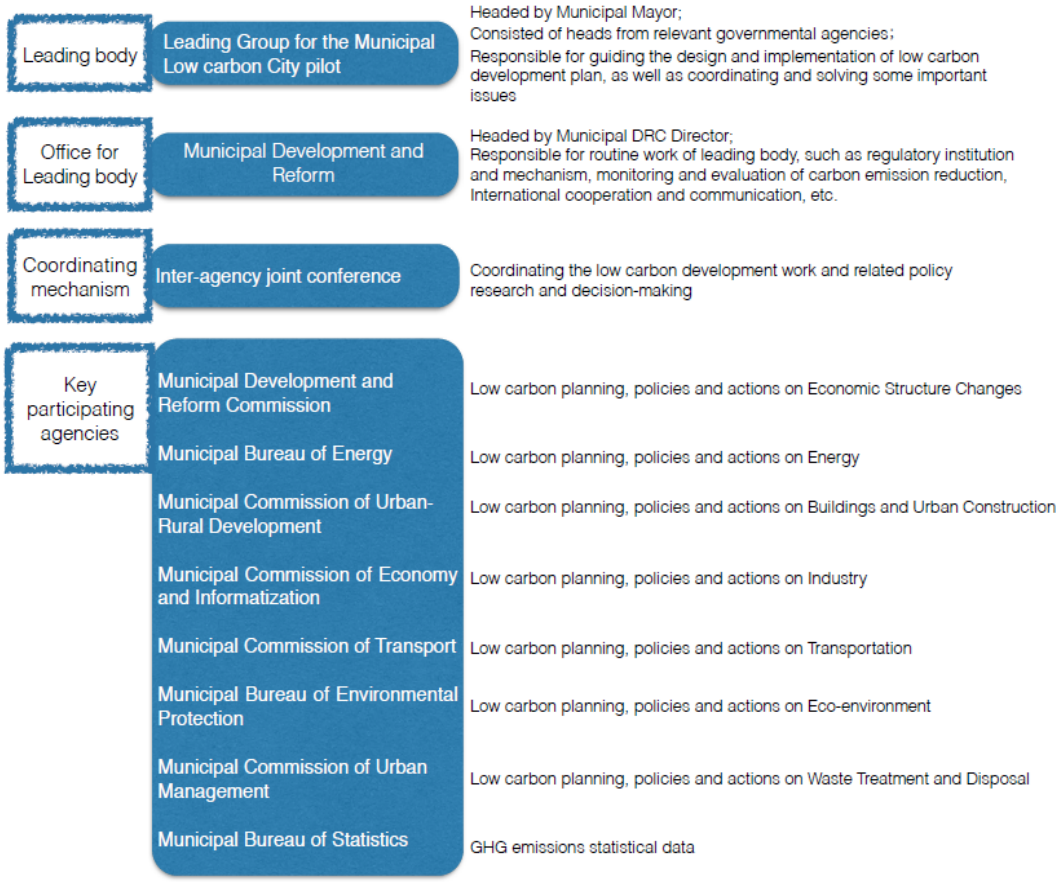

Figure 8: China's Low Carbon Pilot City Administrative Structure (iGDP, 2019)

Japan

Figure 9 provides a schematic view of Japan's climate change policy and the place of cities within it.

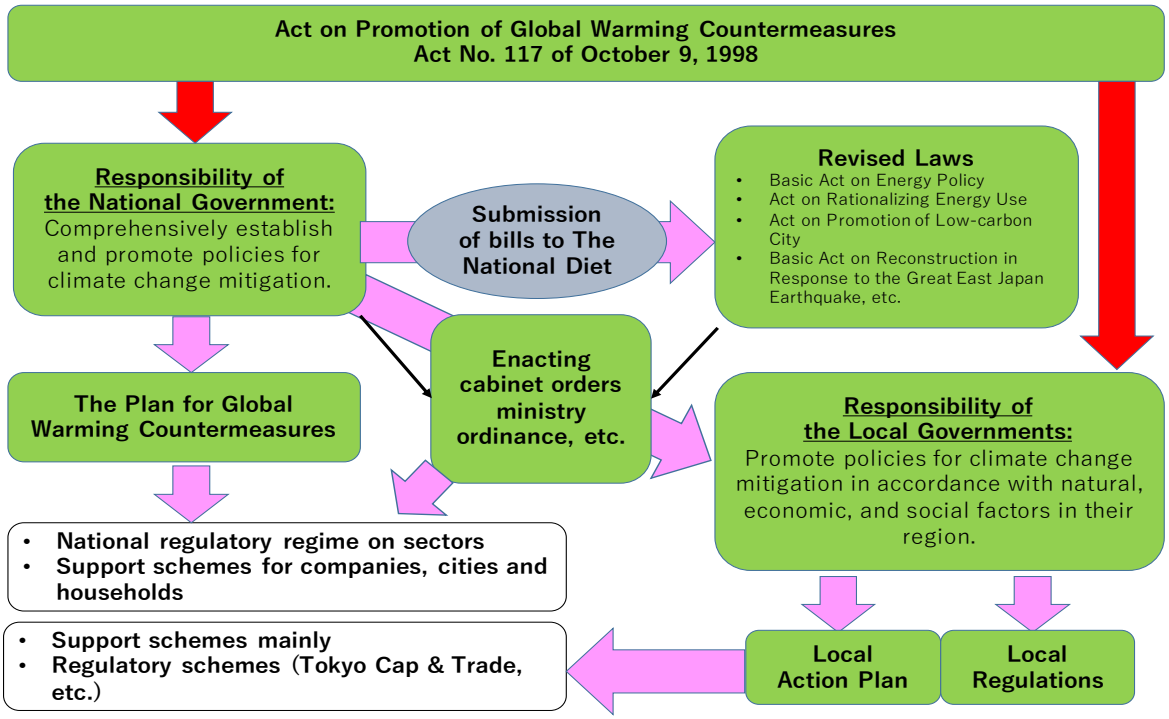

Figure 9: Japan Climate Change Policy Framework (IGES, 2019)

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 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 10.

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 the 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%)	47(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)

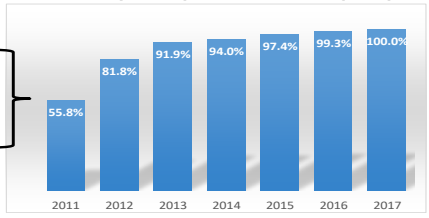

Figure 10: Implementation status of action plan formulation in local governments

Republic of Korea

Some of the major low carbon development efforts at the subnational level in Republic of Korea come through urban planning at the city level. Many provincial and metropolitan city governments focus on improving local and regional transportation networks. Kamal-Chaoui et al. (2011) note that Daegu, Daejeon, Gyeonggi-do, Jeollanam-do, Gyeongsangbuk-do and Jeju all included specific transportation measures in their local action plans. Gyeongsangbuk-do, is planning to build a hydrogen highway along the eastern coast of Republic of Korea. Seoul has stood out in its green retrofitting efforts and Green Architecture Standard, which is equivalent to the international LEED standard, and a prerequisite for all new public buildings (Kamal-Chaoui et al., 2011).

Cities in the Republic of Korea have limited fiscal autonomy. This hampers their ability to initiate large and expensive low carbon strategies on their own. Many cities have responded to this with innovative efforts to promote voluntary climate action by citizens and industries in their jurisdiction. For example, both Changwon-si and Seoul have developed programs where citizens receive "miles" for reducing emissions from their daily activities such as energy use. These miles can then be redeemed for vouchers (Kamal-Chaoui et al., 2011).

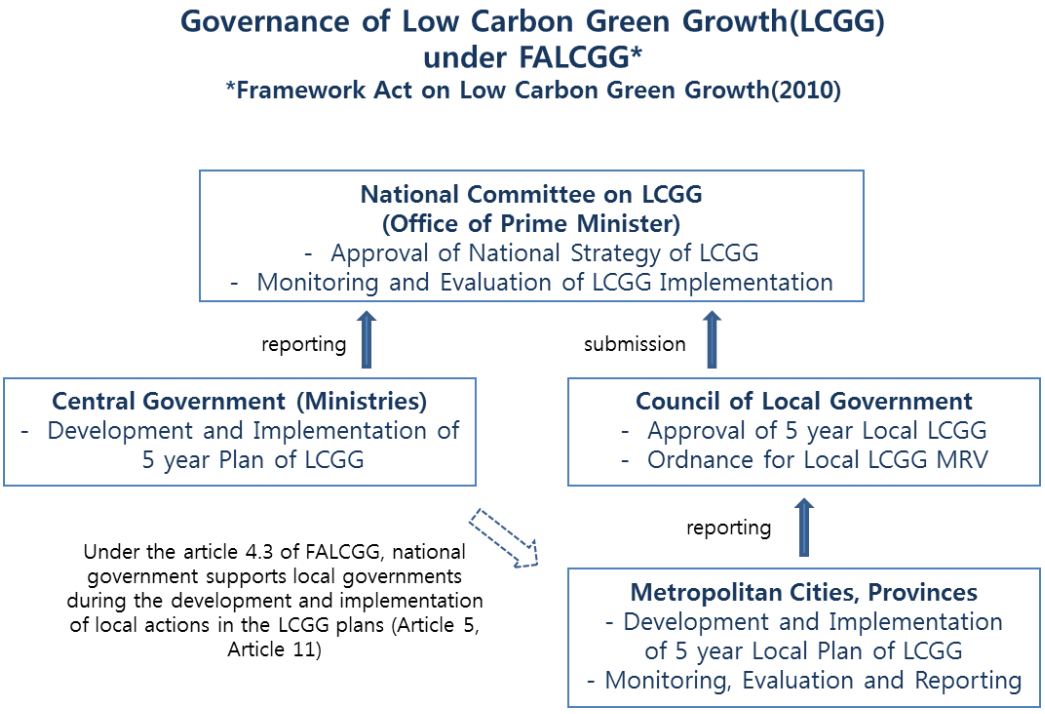

Figure: 11 Governance of Low Carbon Green Growth

Different agencies of the government 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).

Comparative Analysis of Low Carbon City Policy

A. Governance and Institutional Structure

A key point of comparison among cities in the three countries is their fiscal and policy autonomy. As discussed, the political system in China is highly decentralized with much of the business of government delegated to subnational levels, 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 Republic of Korea, 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 both envisioning and implementing low carbon development. At the same time, due to China’s top-down planning approach that sees local governments being assigned specific targets for a range of low carbon development indicators, the political room for independent policy innovation on the part of cities is somewhat limited. Cities in Japan and Republic of Korea, by and large, rely significantly on central government direction and resources. There are some exceptions to this among Japan and Republic of Korea’s large prefectural-level and municipal cities, however, such as Tokyo and Seoul, for example, with the latter having 89% fiscal autonomy (compared to only 50-70% for other major cities and even less for smaller ones in Republic of Korea) (J.-S. Lee & Kim, 2016).

Despite having less financial autonomy, however, Republic of Korea, and particularly Japanese cities have more institutional political leeway in driving their low carbon development. Unlike Chinese cities, those in Republic of Korea and Japan do not have sectoral targets handed down to them from the national government. Although in practice cities in Republic of Korea 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.

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, cities in Japan and Republic of Korea 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 Japan and Republic of Korea’s compared to those like China’s. 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.

The distribution of authority and inclusiveness regarding low carbon policy development also varies across the three countries. In China, although the NDRC will continue to play dominant role in overall economic planning, the transfer of the climate change department to the newly formed MEE looks set to give low carbon development efforts a new level of integration and coordination with other environmental policies. In Japan and Republic of Korea, 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.

Japan and Republic of Korea have institutionalized public mechanisms for stakeholder engagement into 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 help set and review the mid-term goals of the country and contribute to related policy planning processes through setting and implementing voluntary mid-term reduction targets. In Republic of Korea, the multi-stakeholder Presidential 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 is an example of a formal organization that is designed to gather input into China's environmental policy broadly.

B. National-Level Low Carbon City Policy

The Role of Cities in National Climate Policy Frameworks

Cities occupy a different place in the national climate policy frameworks of China, Japan, and Republic of Korea. Japan and Republic of Korea both have flagship national climate change laws that carve out responsibility for cities to develop their own low carbon/climate mitigation plans. China, in contrast, has a flagship climate policy program specifically about cities: the low carbon cities pilot program. The use of a pilot program approach rather than more blanket approach, such as Japan and Republic of Korea'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. At the same time, China's pilot approach should not be seen as necessarily "narrower" than Japan and Republic of Korea's approach. The number of cities participating in the pilot program (81) is, in fact, greater than the number of Japanese cities required to create area plans (68).

Japan and Republic of Korea'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" as discussed above). In Republic of Korea, on the other hand, creating local adaptation plans is mandatory under the FALCGG but mitigation plans remain voluntary (KEI, 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 for how this should look. The 2016 revision to the Act did, however, clarify that cities must work towards consolidated urban forms due to pressures of an ageing and decreasing population. Republic of Korea's guidance for city plans, which are already voluntary, 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, a number of specific requirements are still given that go further than those stipulated for cities in Japan and Republic of Korea. For example, China's pilot cities are required to create GHG inventories, model emissions pathways, create sectoral targets based on the 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 Republic of Korea 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, but these are for efforts towards achieving centrally mandated Five-Year Plan targets, rather than initiatives emerging from being a low carbon pilot city (Sandalow, 2018). As described above, Japan's 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 example plans. In addition, the "Low Carbon City Act" (Eco-City Act)1 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. In Republic of Korea, the Ministry of Environment supports the development of local GHG inventories and low carbon road maps, while the Korea 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, 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 to this program, China operates a large number of other sustainability-related pilot programs that many low carbon pilot cities participate in concurrently. Table 1 provides a list of these programs.

[1] http://www.mlit.go.jp/toshi/city_plan/eco-city.html

Table 1: Low Carbon Development Pilots Programs in China

Carbon Emission Permit Trading Pilot	Demonstration Work for Financial Policies for Energy Conservation and Emission Reduction
Green Finance Pilot Zone	New Energy Demonstration City
Green Industrial Transformation Development Pilot	National Low Carbon Industrial Park Pilot
Concentrated Solar PV Demonstration Area	New Energy Vehicles Promotion and Application Pilot
Green Circular and Low Carbon Transportation Pilot	Transit Metropolis Pilot
Demonstration Projects of Urban Walking and Bicycle Traffic System	National Green Ecological Demonstration Area
Low carbon Community Pilot	City Betterment and Ecological Restoration Pilot
Alliance of Peaking Pioneer Cities	Demonstration Projects Using Renewable Energy in Buildings
Comprehensive Pilot Projects on New-Type Urbanization	National Ecological Civilization Demonstration Area
National Smart-City Pilot	Sponge City Pilot
Kitchen Waste Resource Utilization Technologies and Harmless Treatment Construction Pilot	Domestic Waste Classification Pilot

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 significant overlap between the objectives of these programs. Khanna, Fridley, & Hong (2014) argue that this can create administrative confusion and burden that hampers their effective implementation. Similar issues have been identified in Republic of Korea, where, although there are fewer pilot initiatives than in China, there are still several ones with very similar aims operated by different government authorities. Kamal-Choui et al. (2011) say this has at times led to conflict among the managing ministries, redundancies, and inefficiencies in expenditure and implementation. Khanna et al. (2014) also note, however, that the range of pilot programs in China may offer greater flexibility to cities as they try to pursue locally-appropriate low carbon development.

Unlike in China and Republic of Korea, 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 through which cities can apply to be officially recognized for 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 organized 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 Japanese and ROK model city programs are also broader than those in China, encompassing future-oriented issues that are not directly related to low carbon development, such as super-aging 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 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 Republic of Korea 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.

Table 2 Target Setting

	China	Japan	Republic of Korea
City targets	Emissions peaking between 2020-2030	Average of 19% reduction by 2020/2030 (FY2008-10 baseline years)	30% below BAU by 2020
National targets	Emissions peaking by 2030	25% reduction by 2020 (1990 baseline year)[2]	30% below BAU by 2020
(Potential) emissions reduction burden of cities	36 cities and 6 provinces account for 54% of CO2 emissions (2013)	Area-wide city plans cover 65% of CO2 emissions (2018)	26% of national emissions in 2020 to fall under the mitigation jurisdiction of local governments.

Policy Approaches

Cities in China, Japan, and Republic of Korea take different approaches to promoting low carbon development, often in ways that reflect their varied administrative-authority structures described above. Three broad categories of tools that cities employ include voluntary approaches, those that focus on encouraging self-driven action by other actors; market-economic approaches, those that use investments and economic incentives to drive action; and command-and-control approaches, those that compel action through regulatory authority. This section compares how these different approaches have been taken by cities in China, Japan, and Republic of Korea.

One of the keys to understanding the variation in policy approaches among cities in China, Japan, and 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 and where barriers to policy design, implementation, and monitoring may occur, with all these potentially varying across sectors in line with how power is devolved. This is also a key finding from

[2] This is the target set at COP15 in 2009. It was updated in 2013 due to the Great East Japan Earthquake to a 5-9% target reduction. The 2009 target is used for this comparison because the data presented for the city-level targets is from the time during which this was still the target.

C40's 'Powering Climate Action' report. Which presented a typology of six urban governance structures that reflect variation in the breadth and depth of city government powers and authorities. This is replicated here in Figure 18.

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 foster low carbon development (Liu, Matsuno, Zhang, Liu, & Young, 2013). Still, Wang et al. (2015) note that although voluntary approaches tend not to be dominant among China's LCCP's, a range of them are deployed including low carbon transportation and industry park pilot projects, promoting zero-carbon buildings, and developing carbon monitoring tools.

In contrast, cities in Japan and 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 considering their own low carbon policy as well as to support and encourage 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 Republic of Korea, the "Green Start Movement" is a good example of this. Supported by local governments, it is a network of local multi-stakeholder groups that promote low carbon lifestyles through green education and awareness raising (Kamal-Chaoui et al., 2011). Due to their low cost, voluntary approaches are popular for cities in all three countries. As such, they also are relatively more prominent in the overall suite of approaches taken in cities in Japan and Republic of Korea, which have generally 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 Republic of Korea and Tokyo and Yokohama in Japan. Due to their economic and political prominence, these mega-cities are able to deliver more comprehensively promote low carbon activity in their jurisdictions. Seoul stands out in Republic of Korea due to its exceptionally high fiscal autonomy, allowing it to develop and pursue its own initiatives in ways that most cities in Republic of Korea cannot (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 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-economic approaches. While command-and-control approaches, as mentioned, predominate, some of China's LCCPs also invest significantly into clean energy development, subsidized loans, and other subsidies (Wang et al., 2015). Most cities in Japan and Republic of Korea lack of the capacity and fiscal autonomy to do this at scale, but some have developed interesting incentive programs based on "points" and certification schemes that promote business and household emission reductions. Perhaps the most prominent market-based instrument is the development of an ETS, and while they are most commonly created at the national-level, both Tokyo and Chinese LCCPs have developed them at the municipal level. While Tokyo was the world-leader in this regard, it remains the only one in Japan, with an ETS not having emerged at the national level. Seven of China's LCCPs have piloted an ETS and, unlike for Tokyo, these are actively part of a central government scheme to develop an integrated national ETS. No cities in Republic of Korea operate an ETS as a national system has been in place since 2015.

Good Practices

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, arranged by country, highlight three aspects of low carbon practice: effectiveness and efficiency, sustainability and transferability (the relevance of the policy or practice to other cities). The case studies also provide illustrations of 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 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 organizes fifteen good practice case studies against these four analytic dimensions. While most of the case studies provide illustrations of all four analytic dimensions, some provide powerful examples of one particular approach.

Table 3: Case studies by Local-level Low Carbon City Policies and Approaches

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. Qinghuangdao 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. Transportation: 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 - Transportation (community based public participation)	4. Gwangju Metropolitan City - Financial Incentives for Low Carbon Lifestyle

Ambition and Leadership

In China, Japan, and 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 in 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. 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.

In Republic of Korea, where there is also a top-down approach to low carbon development and cities have limited fiscal independence, most cities have adopted the national target. 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. However, selected cities in both Republic of Korea and Japan have undertaken ambitious projects to refashion large parts of their energy and industrial sectors, or transportation infrastructure, in a conscious effort to become champions of progressive energy and climate policy.

In 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. In Japan, Miyama Smart Community has developed a system to produce and sell renewable energy in a manner that allows revenues to be cycled back into social support services that counteract population decline, the relocation of younger generations to other areas, and the shrinking of the local economy. Miyama is providing an innovative model for other communities that are looking for ways to address climate change and local social challenges at the same time.

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 the use by local municipal authorities of their wide powers to reshape major features of the local urban landscape.

Command-and-control measures are also used in Japan and Republic of Korea in the construction of ambitious, large scale carbon-reduction schemes, as noted above. In Republic of Korea, the development of the Urban Carbon Management System in Gwangju is city-wide effort. The city of Gwangju signed Republic of Korea's first agreement with the Ministry of Environment to undertake ambitious climate actions. Gwangju currently has 74 project-level low carbon initiatives in four sectors. 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.

Voluntary Tools and Stakeholder Engagement

Cities in Japan and 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. To do this, the city established the Yokohama Smart Business Association, a new public-private collaborative council. This 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 Republic of Korea case study of the city of Suwon. Suwon, which aims to become the 'Environment Capital of 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 40% lower than the emission level in 2005. In China, the success of the Energy Efficiency Building Project in Qinghuangdao also depended on stakeholder engagement. A key project success factor 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. 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, where CO_2 emissions from these sectors account for about half of the metropolitan area's emissions. In China, although Shenzhen only accounts for a small proportion of total carbon emissions in the country, the local ETS far exceeded the 21% reduction target set by the central government for Shenzhen during the Twelfth Five-Year Plan period, the local ETS managers are now serving a leading advisory role in the development of the national carbon market. In 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 low carbon lifestyle in consumption of energy and water services.

Conclusion

This report has compared the experiences of low carbon city development in the three Northeast Asia sub-region countries China, Japan, and Republic of Korea with the aim of drawing lessons and identifying challenges and prospects for each country. It sheds light on low carbon city policy by looking at carbon emission drivers, institutional structures, major national and subnational policies, and illustrates these institutional and policy features using case studies. This study brought together experts from China, Japan and Republic of Korea for the analytic review, as well as to provide recommendations and technical support, identify policy or research gaps, generate practical knowledge, and address specific instances of low carbon city development in North-East Asia.

This concluding section now proceeds to outline challenges and recommendations based on these findings. 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 occurring. Even though there are many lessons that 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.

The discussion below contains two parts. The first part addresses challenges that are common to the three countries in this report. The second part describes challenges that are unique to each individual country.

Common Challenges in Low Carbon City Development

Ambition

In China, the low carbon pilot cities are expected to lead in the fulfilment of the national target. In Japan, the mitigation targets of cities are generally less ambitious than those of the national government. In the Republic of Korea, which also has a top-down approach to low carbon development, most cities have adopted the national target as their own. In general, however, most city targets (and national targets) fall short of the ambition required to meet internationally agreed upon objectives such as the goal of keeping global warming below 1.5 or 2 degrees, as enshrined in the Paris Agreement.

Support from National Governments

National governments can provide policy coherence (particularly important in China where there are multiple pilot programs with overlapping mandates), help align national and local infrastructure and energy development plans, create market and financial regulations that affect investment decisions broadly, and provide funding and capacity building services for local efforts. Because China's low carbon policy system is largely top-down, the recent institutional reform that moved the Department of Climate Change from the NDRC, China's influential economic planning agency, to China's new Ministry of Ecology and Environment, may destabilize the critical national level leadership behind the low carbon pilot program. In Japan, local government plan formulation rates are uneven and are not concentrated in the most important areas. The prefectures that have the highest rates of energy consumption do not currently have the highest rate of plan formulation. In Korea, local governments are now updating their local GHG reduction roadmaps in response to the 2018 revision of Korea's national mitigation roadmap, which aims for a 37% GHG reduction from BAU 2030. The national government could use this opportunity apply lessons learned from municipal low carbon practices in the preceding years to these new plans.

Capacity

In Japan, the national government's annual survey of local governments found that more than 80% of local governments have indicated (1) a lack of human resources as a challenge in formulating low carbon plans (2) a lack of a dedicated department for climate change issues. Cities in both Japan and Republic of Korea also generally have limited fiscal autonomy, which makes 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, highlight that expertise and technical capacity regarding low carbon development strategies and policies is severely lacking.

Political and Economic Uncertainty

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 in favor of economic stimulus, including the deeper entrenchment of fossil fuels for primary energy, motivated by an energy security imperative. The on-going trade tensions between China and the USA also have global ramifications that will affect trade in green technologies. China also faces a set of unique domestic political uncertainties related to its institutional restructuring. The movement of China's Department of Climate Change from the NDRC to the MEE is an on-going process; exactly how it will play out remains to be seen. Although it may prove to be beneficial to low carbon development in the long term, such significant restructuring can create uncertainties and lapses in enforcement until all the kinks are ironed out.

Data Transparency, Consistency, and International Coordination

China has recognized this and has made the development of GHG inventories and green indicators a priority. Likewise, Japan's support for cities in developing their local climate plans contains a significant data component. Republic of Korea's FALCGG (Framework Act on Low Carbon Green Growth) recommends the development of local GHG inventories but does not require them and while some larger cities have done so most have not, 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.

Recommendations

Promoting low carbon city development is simultaneously urgent and challenging. This report has provided an analysis of the structure and status of low carbon city policy and action in China, Japan, and Republic of Korea, and has outlined the key challenges each country is facing as it pushes these efforts forward. While the national circumstances in each country vary, some common ways forward can be recommended. This section offers general recommendations in view of differing national circumstances.

Link to Co-benefits

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 framed purely in terms of reducing 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. One way to overcome this is by drawing clear 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 improves 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.). Emphasizing the co-benefits of low carbon policies can also help cities overcome financial and capacity constraints by helping them connect to a wider 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. 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 Republic of Korea, but the depth of analysis is restricted by the amount of accessible data. Perhaps most importantly, the lack of data over time 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).

Being able to track the impacts of low carbon city policy is crucial to ensuring their effective implementation and helping share the benefits of such policy to encourage action on a wider scale. Hsu et al. (2019) paint a clear picture of the road ahead for quantifying subnational and non-state climate action, stressing the importance of converging on consistent methodologies as a key next step. 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 off financial incentives and the presence of regulatory support" (UNEP, 2018). National governments should look to encourage such alignments domestically and regional organizations should do so transnationally.

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 large. 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 touched upon on 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 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 a wide variety of 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. NEASPEC's North-East Asia Low Carbon City Platform is a step in this direction. ICLEI East Asia provides excellent technical and capacity building services to its

network participants but operates on 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 a tools, mechanisms, or platforms that facilitate the transmission of know-how across national boundaries.

This know-how should also be channeled in the right direction and should address the specific challenges of the country or local government receiving support. China, Japan and Republic of Korea 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 truly relevant in other contexts. Japan and Republic of Korea's responses to the emissions effects of aging 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 exported to developing economies under the Belt and Road initiative. But these observations are of surface characteristics. Matching the demand for targeted policy advice with the right experts or lessons-learned will require deep dives into local conditions. As this report shows, low carbon city policy is not one-size fits all.

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