UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

MPFD POLICY BRIEFS
No. 54, May 2017

Role of governance in clean energy innovation policies in East and North-East Asia

The major economies in East and North-East Asia are at the forefront of technological advancements and play an increasingly significant role in developing energy-efficient and renewable technologies. China accounts for the highest percentage of the world's patent filings in climate change mitigation technologies, such as biofuels, solar thermal and solar photovoltaics.[1] Similarly, Japan and the Republic of Korea have a high concentration of patents in fuel cells, cleaner coal, nuclear energy and electric and hybrid technologies.[2]

In terms of commercial investment in clean energy, the global share of China and Japan stood at 31 per cent and 13 per cent in 2014 respectively. In leading global investment in renewable energy, with investments valued at $102.9 billion in 2015,[3] China has also stepped up its overseas investment in wind and solar energy thanks to policy and financial support promoting outbound investment in renewable energy. Going forward, China, Japan and the Republic of Korea have committed themselves to double spending on research and development for clean energy over the period 2016-2020, with the aim of making clean energy more affordable.

Within the broader policy framework to catalyze the low-carbon transformation, innovation in support of sustainable growth has contributed to some early gains. For example, China's energy efficiency improved by 5.6 per cent in 2015, up from an average of 3.1 per cent per year over the past decade.[4] Excluding China, the global energy efficiency gain was smaller at 1.4 per cent in the same year. Recent data also point to some decoupling of economic growth from energy-related GHG emissions in the subregion. In Japan, amid zero economic growth in 2014, total primary energy supply (TPES)[5] and carbon dioxide emissions decreased by 3-4 per cent. In China, when the economy expanded robustly at 7.3 per cent in 2014, TPES and carbon dioxide emissions increased modestly at less than 2 per cent. Nonetheless, despite the progress, East and North-East Asia consumes almost one third of global energy, while producing about one fifth of the world's energy output. China still accounts for almost half of the world's total consumption of coal, although this proportion is set to decline as the economy continues to restructure towards less energy-intensive industries.

Selected policy experiences for other Asia-Pacific countries

The experiences of major economies in the subregion point to at least three desirable aspects of public policies and strategies in promoting clean energy innovation. These aspects include a well-designed governance structure, balanced policy mix of incentives and regulations and an enabling financial system. The list is clearly not comprehensive as other policy aspects, such as the need to develop a large pool of educated workers and to have an open trade policy to facilitate technology transfer, are equally crucial.

The first dimension is a governance structure that features sustainable development as an integral part of national development plans, a whole-of-government approach to implement such plans and multi-stakeholder partnerships. At the strategic level, sustainable development[6] appears prominently in the subregion's national plans. Green innovation policies in China, Japan and the Republic of Korea go beyond promoting niche green sectors and relate to achieving concrete targets, such as the reduction of carbon dioxide emissions.

As part of well-designed governance structures, China, Japan and the Republic of Korea all adopted a whole-of-government approach to promoting sustainable development. In these countries, innovation policies are coordinated directly under their respective prime ministers' offices.[7] In the Republic of Korea, various ministries worked together to prepare comprehensive sustainable growth plans at sectoral and local levels.[8]

Such plans are linked with other relevant areas of public policies, such as market entry, human resources development and international cooperation and collaboration with the private sector. In Japan, the Council for Science, Technology and Innovation takes the lead in the formulation of the overall government budget for science and technology. To ensure that public spending on energy technology is effective, *ex ante* interim and *ex post* evaluations of energy research and development are carried out in the Republic of Korea.

Another important component of governance structure is multi-stakeholder partnerships, partnerships, particularly between the business sector and international entities, running from the development to diffusion of technological innovation. In Japan, the cross-ministerial Strategic Innovation Promotion Programme functions beyond the government framework, and each project director is responsible for coordinating with industry and academic entities on end-to-end focused research and development. Similarly, Japan's open innovation hub brings together industries, academia and government to engage in research, technical evaluations and standardization efforts. In China, a large proportion of funding on science and technology was given to large State-owned institutions, a situation which has led to the establishment of innovation start-ups and university demonstration bases.

The second desirable aspect of the governance structure is a policy framework in which governments consider the use of both economic instruments and regulatory policies to promote the low-carbon transition. Carbon pricing and phasing out fossil fuel subsidies will be critical elements of the policy framework.[9] Examples of economic instruments include emissions trading systems in Japan, Korea and China, taxation on pollution and subsidies for renewable energy products. In Japan, the tax on emissions of sulphur oxides introduced in the 1970s led firms to undertake or adopt significant technologies to reduce pollution.[10] In 2012, Japan introduced feed-in-tariffs in which power utilities are required to purchase electricity from renewable energy sources for a certain amount of time at a fixed price. Such schemes served as an important driver in the early deployment of solar power, which now reaches more than 1.5 million households.

On regulatory policies, a common policy example is setting minimum energy efficiency standards. For example, Japan's Top Runner Programme set as the standard the efficiency of the most efficient product in a given category. China adopted a similar mandatory energy savings programme, with efficiency benchmarks, shortened schedules to achieve the standards and other policy incentives.[11] Another type of regulatory policy is the increasing share of renewable energy use. In the Republic of Korea, a renewable portfolio standards programme requires power companies to steadily increase their renewable energy mix in total power generation.

Evidence suggests that a balanced mix of economic instruments, regulatory policies and technological innovation is desirable. In China, research and development on green technology is a powerful driver of efficiency improvements when combined with increases in energy prices.[12] When the renewable energy law was put into effect in 2005, China created a feed-in tariff system, with a mandatory connection and purchase policy and funding mechanisms. Similarly, the experience from the Republic of Korea suggests that financial support to develop low carbon energy technologies may not effectively deliver the targeted reduction in emissions if complementary pricing reforms are not in place.[13]

The third desirable aspect of governance structure is an enabling financing system. Access to finance by firms carrying out innovation is often limited because they are capital-intensive, involve a long payback period, and because financial returns to research and development are difficult to predict accurately. Meanwhile, bank lending usually requires tangible collateral and has much shorter maturity. In the case of the energy sector, research and development spending is also hampered by various potential market failures, such as indivisibility and spillovers reducing private incentives for investments, and slow diffusion of technology. Therefore, there is a clear role for Government to support basic R&D research which can allow green innovation to flourish.

Countries have launched an increasing number of non-traditional, green instruments, such as green bonds, credits, development funds and carbon finance. China introduced green bonds, that is, it ensures that funds are applied exclusively to finance new and existing green infrastructure projects in order to help significantly scale up the use and development of renewable energy and other projects. China's guidelines on establishing a green financial system, released in 2016, include a series of policy measures to support and incentivize green investment, create a national green development fund and provide a mandatory environmental information disclosure system.

Fiscal support has helped to promote green innovation in the subregion. Nearly 80 per cent of the country's fiscal stimulus in response to the 2008 global economic and financial crisis was spent on green measures and investments,[14] which help to create a market

for green innovation. To catalyse investments in green technologies among small and medium-sized enterprises, which often lack a track record and financial soundness, the Republic of Korea has adopted a technology appraisal system as the basis for providing guarantees and insurance for such enterprises.[15] At a broader level, cross-country evidence shows that long-term policy stability and credibility are critical to ensure financing for innovative green ventures.[16]

Working together to achieve sustainable development

Given these policy experiences, a related issue is how the major economies in East and North-East Asia could collaborate with other subregional peers and beyond to secure sustainable development in the Asia-Pacific region.

Beyond the subregion, there has been a wide range of regional partnerships through knowledge-sharing, capacity-building and financing facilities. On technical cooperation, a recent example is the "Enevolution" initiative launched by Japan to provide developing countries with a one-stop mechanism, including technical support, for preparing energy policies. Another example is the Green Technology Center-Korea, which links the Republic of Korea's public-private cooperative green technology research projects with the demand for green technology from developing countries. Finally, a new centre is planned jointly by China's National Energy Administration and the International Energy Agency to enhance collaboration in such areas as energy data, renewable energy policy analysis and clean energy technologies. China is also increasingly engaged in global energy governance to strengthen energy cooperation as well as take the lead in discussions involving energy interconnection and collaboration in sustainable energy.[17]

On financing, the Republic of Korea's International Joint Energy R&D Program since 2011 has provided financial aid for energy innovation through international joint research and development activities. Japan, through its Joint Crediting Mechanism, has subsidized projects in Mongolia and several other developing Asia-Pacific countries to facilitate the diffusion of low carbon technologies and implement mitigation actions.

Domestic reforms remain key to successful green innovation

The role of domestic structural reforms in pushing forward sustainable development cannot be overemphasized. Successful green innovation requires policy shifts on several fronts, such as the reorganization of government agencies, amendments of energy and environmental laws and policy and regulatory frameworks for innovative financial products. The overall aim is to create enabling conditions that support the business sector to carry out more innovation in respect of clean and efficient technologies by creating markets and incentives to move towards the low-carbon transformation. In China and the Republic of Korea, the share of gross domestic expenditure on research and development in GDP roughly doubled between 2000 and 2014: to 2.8 per cent in China and 4.3 per cent in the Republic of Korea. As in Japan, large research and development spending in both countries is driven by private enterprises. China's research and development spending on renewable energy technologies rose to 4 per cent in 2015, reaching as high as $2.8 billion and matching Europe's spending.[18]

Some progress is being made in lagging economies. In Mongolia where energy intensity remains high, the Parliament approved the Sustainable Development Policy in 2014 and the Mongolia Sustainable Development Vision 2030 in 2016. Among other goals, the plans are aimed at increasing the use of innovative technologies in the production sector and reducing GHG emissions by 14 per cent from the current levels. However, the journey towards green innovation is a long one. In the case of the Republic of Korea, the initial policy focus was on promoting learning about technology (1960s and 1970s), then developing domestic research and development capability (1980s), before developing a more advanced innovation system in the 1990s.[19] Overall, the green innovation track and related policies need to be adaptive to specific country circumstances. With limited resources, developing countries may focus on innovation that make existing technologies less expensive or adapt existing technologies for new uses.

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[3] Frankfurt School-UNEP Collaborating Centre, and Bloomberg New Energy Finance (BNEF), *Global Trends in Renewable Energy Investment 2016* (Frankfurt: Frankfurt School of Finance and Management, 2016). Available from http://fs-unepcentre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2016lowres_0.pdf.

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[5] TPES is calculated as the sum of production, net trade and stock changes of fuels, such as coal and gas. Fuels are subsequently transformed into other energy forms, such as electricity.

[6] Green development implies policies that either reduce resource use per unit of value added incrementally (relative decoupling) or keep resource use and environmental impacts stable or declining while the overall economy is growing (absolute decoupling). Absolute decoupling is essential for achieving sustainable development.

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The MPFD Policy Briefs aim at generating a forward-looking discussion among policymakers, researchers and other stakeholders to help forge political will and build a regional consensus on needed policy actions and pressing reforms. Policy Briefs are issued without formal editing. This issue was prepared by Dorothea Lazaro of ESCAP Subregional Office for East and North-East Asia. This policy brief benefited from comments by Nobuko Kajiura, Hamza Ali Malik, Sangmin Nam, Kilaparti Ramakrishna, and Vatcharin Sirimaneetham. For further information on this issue, please contact Hamza Ali Malik, Director a.i., Macroeconomic Policy and Financing for Development Division, ESCAP (escap-mpdd@un.org).

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