Chapter 11 Green Growth and Low Carbon Development in East Asia: Achievements and Challenges

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As mentioned in this book's introduction, Northeast Asian countries have been framing green growth and low-carbon development as a green industrial policy that is compatible with conventional export-led industrialization, with a special focus on renewable energy. Through this framing, they have hoped to garner multiple benefits: developing leading manufacturers in prominent industries around the world; increasing green jobs; enhancing the international competitiveness of their industries; reducing carbon emissions; and enhancing their energy security.

This chapter summarizes the findings of the previous chapters and evaluates the Northeast Asian countries' achievements and remaining challenges, with a special focus on energy and trade. Then it explores how green growth, low-carbon development strategies can be applied beyond Northeast Asia.

1. Achievements

1.1 Development of renewable-energy industries

China and South Korea have dramatically increased their production and export of green products. In Chapter 5, Ogura and Mori showed that the international trade of green products has increased steadily in Northeast Asia, reaching 10 percent of the total trade volume. In particular, exports of renewable energy technologies and products have risen dramatically.

A remarkable increase can be seen in solar power as well. Chinese manufacturers of solar photovoltaics (PV) modules have capitalized on economies of scale to increase exports. When the Chinese government implemented a feed-in-tariff (FIT) for solar power in 2012, these manufacturers increased domestic supply, accounting for one-fourth of global supply in the same year (Table 11-1). The Korean company Hanhwa has become a first-tier manufacturer and increased its global market share since it took over the Chinese firm SolarOne and the German firm Q-Cells. Chinese manufacturers have also joined in the more profitable upstream market for polysilicon and silicon ingot (Table 11-2).

<Table 11-1 and 11-2 around here>

Chinese wind turbine manufacturers have also increased production, and exports of wind turbines have increased to a lesser extent. Although Chinese state-owned manufacturers started

operation with the aim of rural electrification, they have rapidly acquired and increased production capacity since the Chinese government enacted the Renewable Energy Law, which implemented a renewable portfolio standard (RPS) and mandated that state grid companies purchase from them. Wind power is the second largest category (by number) of Clean Development Mechanism projects in China (Mori, 2011), and this has helped the government recognize that wind power can bring economic and environmental benefits. This provided state-owned manufacturers with opportunities to acquire knowledge and gain economically (see Chapter 4 in this volume). Some of the manufacturers went further, acquiring technology licenses from second-tier foreign manufacturers who had lost in the competition in the European market and had therefore been willing to sell licenses at a cheaper price. These license agreements were used to establish joint ventures in exporting markets to scale up wind turbines and to develop ocean wind power. This has increased the production and export by Chinese manufacturers, and in 2010–11 they accounted for one quarter of world deliveries (Table 11-3).

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As a result, globally, China hires the largest number of people in renewable-energy related industries. It is estimated that about 2.6 million people work in these industries in China, with 1.6 million people working in solar PV and a further 350 thousand people working in wind power and solar heating/cooling during 2012–13 (RENS21, 2014).

It was not until 2012, when the Japanese government implemented a FIT for renewable energy and mandated that existing electric power companies purchase all available renewable energy, that Japanese manufacturers recovered their share of solar PV delivery in the world market. Japanese manufacturers used to have the lion's share of solar PV module sales and they have invested in efficiency improvements for solar PV, so some of them have the ability to reverse their decline in global market share, which is caused by slow expansion of the domestic market and fiercer competition in foreign markets. Nevertheless, China's excessive supply of solar PV modules, coupled with uncertainty over policy changes, makes Japanese manufacturers hesitant to make huge investments in capacity expansion. Instead, they are investing in related goods such as power conditioners.

Although no South Korean companies appear in the ranks of global leading wind turbine and solar PV manufacturers, the Korean government has created industrial parks to attract manufacturers to invest in polysilicon and silicon ingot production for export. This has resulted in creating top manufacturers in this field (Table 11-2). The government has also been pushing a few manufacturers, such as Samsung, to join the ocean wind turbine market as an entry point to a new

niche, as well as to increase the availability of appropriate renewable energy sources in South Korea.

Taiwanese companies appear among the world's leading solar PV cell manufacturers, as well as among the leading polysilicon manufacturers (Tables 11-4 and 11-2, respectively). This is due in part to the government's prioritization of solar power through the applicable FIT, which reflects Taiwan's strong foundation in semiconductor production (Lin, 2014). Other environmental industries have grown in Taiwan, but face difficulties in enhancing their international competitiveness due to constraints in the domestic and international markets (Chapter 6 in this volume).

Such increases in production affect the trade balance. Japan has been a net exporter of renewable energy equipment since the early 1990s, and China and South Korea became net exporters in 2007 and 2010, respectively (Chapter 5 in this volume).

<Table 11-4 around here>

1.2 Energy system transition for sustainability

China and Japan have shown a significant increase in the installed capacity for wind and solar power. Figures 11-1 and 11-2 illustrate how rapidly the world has increased its supply of wind and solar power during the last decade. Among the listed countries, China has increased its capacity most dramatically. It has rapidly increased the annual installation rate for wind power, surpassing the installed capacity of Germany and the United States in 2010, when it had one third of the world's installed capacity. China has improved its ranking on the installation of solar power since 2011, having the second largest installed capacity in 2013. South Korea, too, has increased its installed capacity, but the scale and speed of improvement has been much more modest than in China. Japan used to have the largest installed capacity for solar power, but the country was left behind recently. This is attributed to the government failing to raise the share of mandatory purchase of renewable energy in the electricity generation market from 1 percent under its RPS. However, installed solar capacity in Japan has shown a significant increase in 2012-13 after the replacement of the RPS by a FIT, coupled with a purchase price high enough to allow independent power producers to earn a profit. In contrast to solar power, wind power use in Japan has increased only gradually, even after the Fukushima nuclear tragedy, which is reflective of its higher transaction costs.

<Figure 11-1 and 11-2 around here>

Investments in renewable energy have increased power generation by renewable sources and their share in total power generation. China has raised that share rapidly since 2008, and Japan has done so since 2012, to reach 2 percent. South Korea and Taiwan have much lower shares, but in those countries the renewable energy share has still increased rapidly since 2010 (Table 11-5).

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2. Challenges

Despite the improvements described above, the share of renewable energy in total power generation still lags behind that in other Asian countries, such as Indonesia and the Philippines, which are rich in geothermal power, and far behind the world-leading countries of Germany and Denmark. In addition, the speed of growth is varied. While China raised its renewable energy targets to accelerate installation of wind and solar PV, the South Korean government ended up extending the deadline for renewable energy targets from 2030 to 2035 in the 2014 National Basic Energy Plan. Japan has yet to set a renewable energy target, leaving the growth of installed capacity to market forces.

In addition to wind and solar power's higher relative costs, there are a number of barriers to widespread adoption of renewable electricity generation. The first barrier is the sporadic nature of renewable energy sources. Renewable energy of most types relies on variable power sources, and an enhanced grid is needed to balance supply and demand at the spot because supply is critically dependent on weather, while demand is not always. The wider the area covered by a distribution grid, the more flexibly its operator can balance supply and demand because it can combine heterogeneous demand and supply. Establishing such systems needs either investment in networking transmission lines or cross-regional coordination of transmission. Under the existing centralized and (regionally) monopolized production systems, incumbent power electricity companies should bear the investment costs and additional transaction costs of adjusting total supply, including volatile supply from renewable sources. However, existing companies have shown themselves unwilling to accept large amounts of renewable sources in their grids, and they refuse grid access by independent renewable power producers because that would deprive them of a source of profit.

The second barrier to the growth of renewable energy is price regulation. In exchanges that allow a centralized regional monopoly on supply, the government keeps strict control on the retail energy and electricity price. Except in Japan, governments offer subsidized pricing for the sake of stabilizing people's daily life, preventing inflation, and supporting industrial development.

Despite its heavy reliance on imported coal, South Korea has offered subsidies to the

agricultural sector and industrial energy customers in order to enhance their international competitiveness and protect them from foreign competition (Table 11-6). This policy has increased the presence of energy-intensive industries, such as steel and petrochemicals. The South Korean government kept electricity price stable during the periods of global energy hike (2007–08) and currency depreciation (2008–12). This resulted in the wholesale electricity price being lower than the price of imported oil, which generated excess demand that eventually resulted in the blackout of the Seoul metropolitan area in 2011. The policy has also widened the financial deficit of the state-owned Korean Electricity Power Company (KEPCO), which was US$ 2.75 billion in 2011 (Duffield, 2014). This makes KEPCO incapable of investing in a grid and transmission system that could accept massive quantities of renewable electricity.

<Table 11-6 around here>

In China, tight price regulation by the government has deterred and curtailed grid connectivity, which has had an adverse impact on the spread of renewable electricity. In the meanwhile, China has refused grid companies' requests to be allowed to pass on the additional costs to consumers. Coupled with an increased coal price, this restriction has deprived grid companies of the financial ability to invest in a unified power grid. Rapid installation of wind power poses additional challenges to grid connectivity in this context because grid companies are required to make huge investments to correct for the geographical imbalance between demand and supply, and the government does not sufficiently compensate this investment. In addition, grid companies must recover losses from paying premium prices to renewable power producers. Even though the Renewable Energy Law requires grid companies to accept increasing volumes of renewable energy, most local grids have refused to establish the necessary connections. The government has not strictly punished the grid companies for this refusal. Coupled with a prohibition against direct provision to end-users, and the numerous small-scale plants that had been installed for the purpose of rural electrification, refusal of grid connection left one-third of wind power plants unconnected to the grid (Fang et al., 2012). Although the rate of idled wind power capacity has dropped to 17 percent in 2012 and to 11 percent in 2013, about 16 TWh were still wasted due to curtailment (REN21, 2014).

Faced these difficulties, the Chinese government aims to shift the focus from large solar farms to rooftop PV as a way to increase smaller-scale distributed solar PV. These developments provide support for the perhaps optimistic view that idled or unconnected capacity is a temporary challenge that can be solved through future institutional changes and system innovations.

The third barrier to the growth of renewable energy is nuclear dependency. Japan, South Korea,

and Taiwan are resource-poor countries that rely largely on foreign imports to meet their increasing energy demand. The two oil crises in the 1970s alerted these three countries to the degree of their vulnerability because of energy dependency, which prompted their governments to diversify energy sources. To enhance energy security and satisfy growing domestic demand, these countries have developed oil reserves, diversified their oil suppliers, which had been mostly Middle Eastern countries, and increased the number and capacity of nuclear power plants. In the process, centralized, monopolized nuclear and fossil fuel-based production systems were established and locked in. Japan implemented an electricity surcharge that was earmarked for local governments that hosted nuclear power plants. Taiwan decided to implement this surcharge several years later to accelerate nuclear development. The electric power companies, politicians at central and local governments, and ministries in charge of promotion and regulatory bodies have grown too close to one another to be truly independent, resulting in a system with insufficient transparency in decision-making and a lack of checks and balances. By 2000, nuclear power accounted for one-third of the total power generation in Japan and South Korea and one-sixth in Taiwan.

Emerging concerns about climate change have spurred the development of nuclear power. South Korean has framed nuclear power as an energy source that can ensure greenhouse gas (GHG) emissions are reduced by the target amount, and as a new export industry. In the 2008 National Basic Energy Plan, the South Korean government set the nuclear share target at 59 percent in 2030, which is up from 33.6 percent in 2007. South Korea rushed to win a competition for the development of nuclear power plants in the United Arab Emirates and is seeking other opportunities. The Japanese government, after committing to a 25 percent reduction in GHG emissions by 2020, has framed nuclear and renewable energy as major vehicles to attain that target. In the 2010 Strategic Energy Plan, the government set the target for the share of renewable at 10 percent of total primary energy by 2020, and that for renewable and nuclear energy at 70 percent of total power supply by 2030. Pushed by South Korea, Japan described the export of infrastructure, including nuclear power plants, as a priority in the 2010 Growth Strategy.

The Fukushima nuclear tragedy has had significant effects on nuclear-based production systems in the region. For example, as a result of the tragedy coupled with a series of incidents and local opposition, South Korea lowered its nuclear target from 59 percent by 2030 to 22-29 percent by 2035 in the 2014 National Basic Energy Plan. However, the plan keeps the nuclear capacity target intact. This implies that the government has no intention to compensate for the reduction by increasing renewable energy: rather, it intends to do this by increasing total generation capacity significantly.

The Japanese government decided to suspend all nuclear power plants until they achieve compliance with more stringent safety standards and are certified by an independent regulatory

commission. In the meantime, it has attempted to change the decision-making process from one in which climate policy is subordinate to nuclear power development and strategic energy plans to an integrative process in which the government makes a joint decision regarding the above three plans, with a reflection of deliberative opinion polls (Chapter 3 in this volume). In reality, however, the government could not make this decision even at the cabinet level. The decision-making process reverted to its original form when a new administration took power.

The fixed FIT offers an opportunity for renewable energy-rich areas to capitalize on this richness to develop local business, although the success of such attempts is critically dependent on institutional capacity (Chapter 2 in this volume). The ongoing unbundling of regional monopolies on vertically integrated supply in Japan is expected to strengthen institutions that are favorable to the development of a decentralized supply system.

Taiwan, having grappled for a decade with the controversial development of its planned fourth nuclear power plant, has committed to a gradual decrease in nuclear power. It announced the phase-out of plants that have operated for 40 years and the replacement of its first power plant with the planned fourth plant if residents and local governments accept its operation.

3. Side Effects in the Globalized World

It is worth nothing that China and South Korea may have realized rapid growth in their renewable energy industries at the expense of other countries.

3.1 Development of renewable energy industries in other countries

Export is one of the key drivers of rapid growth in renewable energy industries. These industries enjoy economies of scale that make production more efficient while reducing costs, creating a comparative advantage in international trade. Thus, the bulk of employment in the sector is concentrated in a few countries, such as China, Brazil, the United States, India, Bangladesh, and some countries in the European Union (EU). This is true even in periods when growth in world demand leads to increased prices and profits. Overinvestment by Chinese manufacturers has placed downward pressure on prices since 2010, leading to cutthroat competition. Relative to the 2008 peaks, wind turbine prices fell by as much as 20-25 percent in western markets and by more than 35 percent in China before stabilizing in 2012 (REN21, 2013: 51). The cost of solar PVs from top Chinese manufacturers approached US$ 0.50 per Watt in 2013 (RENS21, 2014).

This aggressive pricing from China, coupled with policy changes in several European countries, was highly detrimental to wind and solar manufacturers around the world, reducing their revenue margins so much that many have fallen into trouble (Table 11-7). For instance, Suzlon (India), the world's seventh largest wind turbine deliverer in 2011, has lost money for four years running and

has struggled with massive debt. Some wind turbine manufactures in the United States have shuttered their factories due to a shortage of new turbine orders. German Q-Cells SE, formerly the world's leading solar PV manufacturer, filed for bankruptcy. This has had an impact on green jobs. Italy was hit the hardest, with 70 percent of those employed in solar power companies losing their jobs. Germany, too, had 22 percent of its green industry workforce, 100,000 people, lose their jobs (IEA, 2013: 62). The larger share that China occupies in the world's renewable energy equipment market, the greater the share that Japan loses in the global market (Chapter 5 in this volume).

Chinese manufacturers have not been immune to the repercussions of price wars. Sinovel (China), which became the leading wind turbine manufacturer, put workers on involuntary leave. Many suppliers in China particularly have been pushed to the edge of collapse, with overcapacity pushing smaller manufacturers out of the market entirely. Suntech Power (China), which was the world's largest solar PV deliverer, declared bankruptcy in 2013, which caused the loss of 200,000 jobs in the solar PV sector in 2012 (IEA, 2013: 62).

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Despite these casualties, three Chinese companies remain listed in the global top ten of wind turbine manufacturers, and six in the global top ten of solar PV module manufacturers (Tables 11-3 and 11-1, respectively).

By replacing the FIT with an RPS, South Korea is expecting to limit the impact of imported low-price, low-quality renewable energy equipment. An RPS allows Korean electric power companies to procure equipment at their discretion, and so they can implicitly prioritize solar modules that are made of cells, wafers, and polysilicons produced by Korean manufacturers.

3.2 Eco-efficiency in resource use

As discussed in the introduction to this book, the United Nations Economic and Social Commission for Asia and the Pacific defines green growth as the eco-efficiency of economic growth (UNESCAP, 2008). South Korea has enhanced its eco-efficiency through international and domestic reuse and recycling of end-of-use goods. South Korea had implemented a waste deposit system to reduce emissions and enhance recycling when faced with the so-called "not in my backyard" syndrome for developing a waste disposal site. However, associations of Korean industrial companies strongly opposed it, citing its high costs. In response, the government replaced this plan with the Extended Producer's Responsibility (EPR) program. Although imposing on manufacturers the obligation to attain a recycling target for end-of-use electric appliances, it offered export subsidies for international recycling as a complementary measure. This measure may result

in the creation of pollution havens impacts at export destinations where environmental governance is too weak to prevent environmental pollution from the recycling and disposal process. In the case of lead-containing used televisions and computer monitors, Korean manufacturers save recycling costs and Korean society gains the benefit of saving on disposal site costs, while Vietnam, the major export destination, gains little from legally permitted reuse (Chapter 8 in this volume).

Product-related environmental regulations (PRERs) can be policy responses to avoid such environmental pollution in countries of weak enforcement. PRERs require significant or complete reduction of hazardous substances that are contained in a product. Nonetheless, PRERs have not always functioned effectively to advance cleaner production and products in such countries, primarily because the use of PRERs has not created globally unified regulations and standards. As a result, several East Asian countries have taken industrial benefits into account when implementing their own PRERs, while others have suffered from a massive influx of 'dirty' products that do not comply with the PRERs of developed countries (Chapter 9 in this volume).

4. A Model Worth Spreading Globally?

4.1 Leapfrogging in renewable energy industry

At first glance, it looks easier for developing countries to realize leapfrogging in the wind and solar PV industries. A company can capitalize on production modules to assemble parts, components, and material resources even if it lacks the capacity for a complex production process and has few skilled workers. Because the industry has been previously established in developed countries, some suppliers of machinery and equipment offer a series of production line coupled with operational know-how. This enables manufacturers in any country to enhance production capacity so long as they have a certain amount of capital and educated laborers.

However, companies face difficulties in enhancing efficiency and in upgrading quality by themselves. It was not until they purchased a branch of bankrupted European manufacturers that Chinese wind turbine manufacturers could compete with foreign competitors in the global market.

The Chinese government has played a significant role in fostering domestic manufacturers and protecting them from foreign competition. It capitalized on requirements for local content to the benefit of domestic, state-owned wind power companies. As a precondition to obtain a wind power concession, the government imposed a requirement for 50 percent local contents in 2004, and this requirement was raised to 70 percent in 2005. In contrast, companies were nearly exempt from requirements relating to track record or lifetime turbine performance. State-owned companies capitalized on better relations with the government and state-owned banks to ensure access to substantial amounts of state funding, even while enjoying no or limited responsibility to shareholders. This enabled them to invest in less-profitable projects (Buen and Castro, 2012). In

addition, state-owned companies were able to acquire licenses from second-tier foreign manufacturers that had lost in the competition in the European market and were willing to sell licenses at a less expensive price. Under these conditions, private sector and foreign investors won less than 10 percent of the concessions (Li et al, 2010). The winners in the concession are able to obtain financial support for grid connection and access roads as well as preferential loan and tax conditions, which have enabled domestic manufacturers to make massive investment, seeking economies of scale. When the government lifted the local content requirements in 2009, it was confident that domestic manufacturers had become competitive enough to compete with foreign companies. Although Chinese companies had to accept restrictive terms imposed by foreign companies when acquiring licenses, for example, restricting or prohibiting export of the technology or offering licenses for only turbines below 1.5 MW capacity, they have a first-mover advantage in adapting them to local conditions. In fact, the share of Chinese manufacturers in the Chinese market has increased by 27 percent from 2007 to 2013, when it exceeded 93 percent, and European turbine manufacturers have experienced a decline (REN21, 2014: 58).

It was not just the central government that fostered domestic manufacturers. Local governments have provided land grants and subsidies as measures to boost the local economy. The state Communist party evaluates the leaders of local governments according to economic performance during their tenure when deciding on promotions. This process makes it rational for local governments to take targeted policies toward prominent companies under their jurisdiction. This holds true for private companies that have a close relationship with the area.

The Chinese Development Bank (CDB) has provided a massive amount of subsidized loans to private solar PV manufacturers that sought the help of foreign investment banks due to a lack of access to preferential treatment or financial support from the central government. CDB subsidized loans of US$ 14.7 billion to clean energy projects and other energy saving projects. In comparison, the European Investment Bank provided 8 billion euros (approx. US$ 10.6 billion) and the US Federal Financing Bank provided US$ 2.12 billion (Sanderson and Forsythe, 2013: 151). Most of the Chinese companies listed in the global top ten manufacturers of wind turbines and solar PV modules obtained huge credit lines from CDB. The CDB lines of credit had a cowbell effect by providing a guarantee that made commercial banks feel safer lending to these companies, which allowed the companies to obtain cheaper working capital loans from commercial banks. Such loans allowed them to further expand capacity and to drive marginal production costs down.

Local governments and the CDB even rescued these companies when they got into deep distress during 2010-11. The government of Xinyu city, where the company LDK is based, paid a portion of the company’s debt. Yingli sold 1.5 billion yuan (approx. US$ 242 million) of bonds in 2012, with CDB as the lead underwriter (Sanderson and Forsythe, 2013: 154) after it suffered from an annual

net loss of more than 50 million yuan (approx. US$ 8.1 million). This government funding has enabled companies to survive in the global market amid plunging prices. CDB went further, providing credit lines that enabled Yingli to purchase a subsidiary of the bankrupted Q-Cells and take a stake in Sunways AG, a German solar panel and cell manufacturer (Sanderson and Forsythe, 2013: 156).

Few countries have local governments and state development banks that can provide such massive financial resources for targeted industries. Besides, massive financial supports have caused trade wars with leading countries. The defaults of US Solyndra and German Q-Cells SE triggered investigation of anti-dumping and anti-subsidy remedies. The United States announced anti-dumping duties of roughly 31 percent on Chinese PV equipment in May 2012, and the EU adopted an average 47.7 percent duty in December 2013. The United States also announced an anti-dumping tariff averaging 25 percent for PV cells and modules produced in Taiwan in August 2014. Australia announced that it was launching an anti-dumping investigation on finished and semi-finished Chinese PV module imports in May 2014.

4.2 Leapfrogging in energy transition for sustainability

Although centralized, monopolistic nuclear and fossil fuel-based systems for providing electricity have blocked South Korea, Japan, and Taiwan from increasing the use of renewable energy, China has increased its use of renewable energy and reduced its coal dependency, advancing hybridization of its energy infrastructure. Can China be a global model for energy transition for sustainability, and, in particular, do its experiences provide useful lessons for developing countries?

At this moment, the answer seems to be no. First, the growth of solar use in China is in part a consequence of the anti-dumping and anti-subsidy duties imposed on solar PV modules by the United States and the EU. The Chinese government intends to exploit the domestic market to compensate Chinese PV module manufacturers for financial losses resulting from the duties as well as the reduction in the size of the European market. China expects that such measures will direct companies to increase the use of Chinese solar cells and polysilicon. Among developing countries, only India and Brazil have markets big enough to take this approach and keep a competitive environment in the domestic market, which eventually offers an internationally competitive price for renewable energy supply.

Second, it is by massively increasing oil and gas imports that China has been able to reduce its coal dependency and emissions of carbon and other air pollutants. To ensure energy access and energy security, China has mobilized massive subsidized loans to oil and gas rich countries that are not locked up by Western countries, ranging from South Sudan and Angola in Africa, to Myanmar,

Kazakhstan, and Turkmenistan in Central Asia, and to Russia. It is unlikely that other energy importing countries have a foreign reserve large enough that the government and/or state banks can mobilize the funds needed to enhance energy security in the way that China has. Some energy-rich countries have launched energy-saving measures and renewable energy initiatives to prepare for anticipated energy shortfalls in the future, but many countries still have little incentive to widely adopt renewable energy (Chapter 10 in this volume).

4.3 Enhancing transition to sustainable development

Although green growth and low-carbon development strategy have increased employment in the renewable energy sector in China and, to a lesser extent, in South Korea, they have contributed little, if any, to other dimensions of social sustainability. Instead, local governments in China and the CDB have mobilized massive financial resources at the cost of broadening the income gap and social divide. Companies have used agricultural land and bond issuances to obtain financial resources. This has resulted in capital gains from the development of economic infrastructure near the affected land and the conversion of agricultural land to urban development. In the process, an increasing number of local governments have developed local financial corporations that receive CDB loans and use these to grab lands from farmers, and these funds are spent without audit or oversight. They have forcefully relocated farmers, offering only meager compensation, and this has increased social unrest around China (Sanderson and Forsythe, 2013: 21). In South Korea, a small number of conglomerates have benefited from the renewable energy industry but a large number of small companies have not, and there has been no notable effect on the rising unemployment of the younger generation.

Unlike in Northeast Asia, people in Central and South American countries demand a framework of social institutions that nurture and assist people (Dujon, 2009). Residents of these countries have long suffered from economic, social, and political marginalization under neoliberal market policies. Grassroots movements have raised consciousness about the connections among economic survival, environmental protection, and social justice, and these movements have attempted to democratize the state to redefine the path to social well-being and force the state to increase provisions for broad social well-being (Dujon, 2009).

Because of the very different contexts, it is understandable that Central and South American countries have criticized green growth as not contributing to social well-being, and refused to make it a global goal at the UN Conference on Sustainable Development (Rio+20)[1]. To be a globally acceptable agenda, green growth should at least be supplemented by an inclusive growth approach

[1] Chung, Rae Kwon. Presentation at the expert meeting on green growth and sustainable development, Sapporo, Japan, 22 August 2013.

that focuses on a just distribution of resources and on human development[2].

5. Concluding Remarks

Northeast Asian countries have capitalized on their existing industrial bases to adopt a green industrial policy in the face of the global financial crisis. They have focused on renewable-energy equipment industries, such as wind turbine, solar PV cell, and module manufacturing because manufacturers can capitalize on production modules to assemble parts, components, and material resources without needing a complex production process or a mature labor force. The Chinese government and, to a lesser extent, the South Korean government have selectively intervened to foster domestic manufacturers in this industry. Coupled with technological transfer from foreign equipment suppliers, such intervention has created an incentive for many manufacturers to join the market, which has resulted in overinvestment in a limited number of renewable energy equipment types and to price collapses. Although China has avoided inefficient production by the use of protection measures, this has sparked a trade war with the United States and leading countries in Europe. Although lower prices for renewable-energy equipment may accelerate a transition to energy sustainability, the incumbent centralized, monopolistic nuclear- and fossil fuel-based energy production systems have blocked such transitions in Northeast Asia.

Northeast Asian countries have legislated recycling acts to increase the eco-efficiency of resource use, but this has had the effect of increasing the international trade in end-of-life goods. These acts have been criticized for transferring environmental pollution to importing countries with weak governance. Import regulations in China and Vietnam, as well as PRERs implemented in many countries, might have mitigated the adverse impacts, but South Korea still promotes the export of end-of-life goods.

Overall, a green growth and low-carbon development strategy has succeeded in reframing policies on climate and the environment as industrial policies and in rapidly increasing the production and spread of renewable energy equipment in a limited number of countries. The benefits from approaches have been concentrated on a few industries and manufacturers, while the costs have spread across society and to other countries. To advance the global transition to sustainable development, green growth and low-carbon development strategy should be implemented in a way that breaks institutional lock-in, which has blocked such a transition, that minimizes the side effects of change, and that incorporates human development and social well-being.

[2] The World Bank (2012) adopts the concept of inclusive green growth, paying attention to reduction of poverty and improvement of access to health, education, and infrastructure services.

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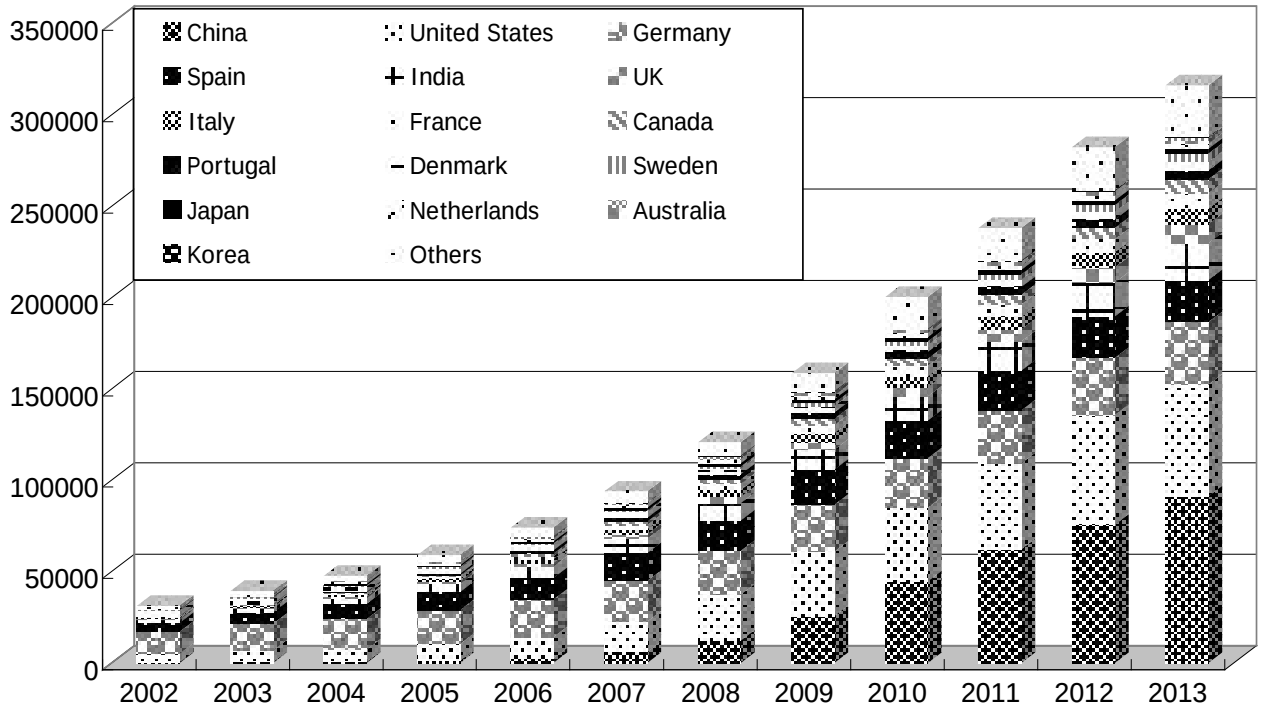
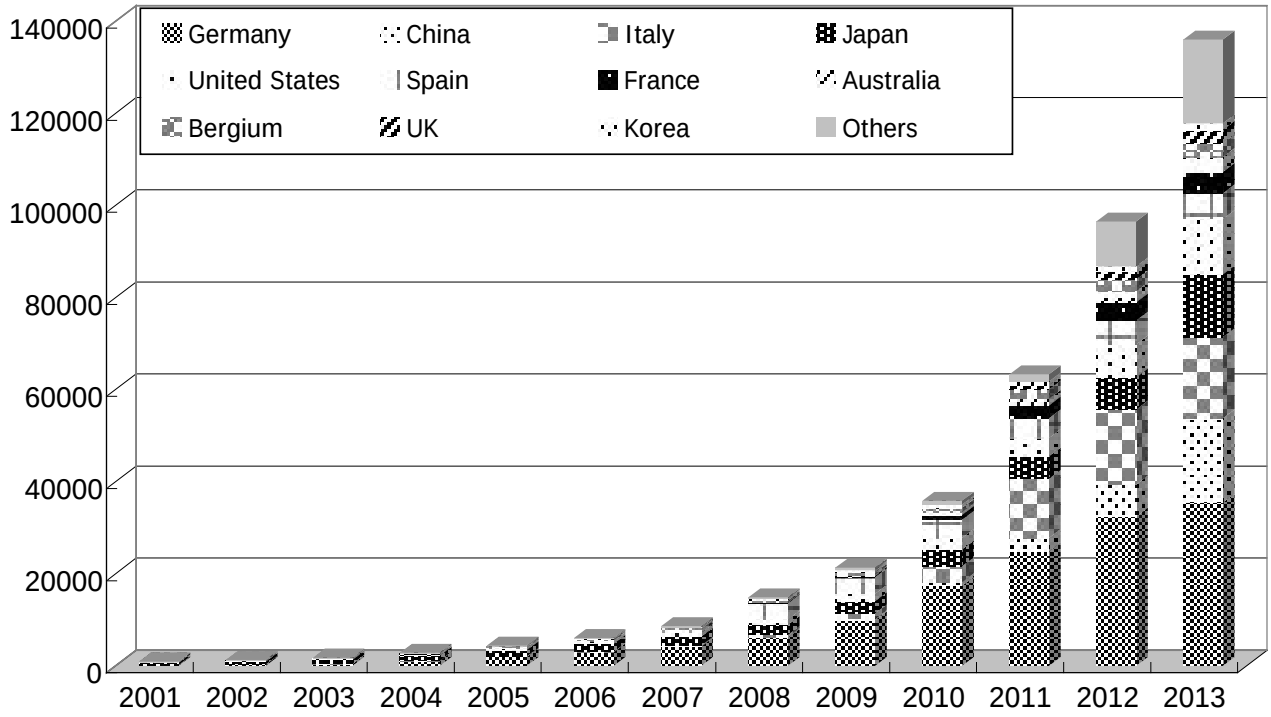
Figure 11-1 Cumulative Wind Power Installation by Country (MW)



Source: Author completion in reference to Global Wind Energy Council (2013; 2014).

Figure 11-2 Cumulative Solar Power Installation by Country (MW)



Source: Author completion in reference to IEA (2013; 2014).

Table 11-1 Top 10 PV Module Suppliers in 2012

Ranks in 2012	Company Name	Delivery in 2012 (MW	Global Market Share (%)		
			2011	2012	2013
1 (3)	Yingli (China)	2300	4.8	6.7	8.2
2 (2)	First Solar (USA)	1800	5.7	5.3	4.2
3 (4)	Trina Solar (China)	1650	4.3	4.7	6.7
4 (1)	Suntech (China)	1650	5.8	4.7	-
5 (5)	Canadian Solar (China)	1600	4.0	4.6	4.9
6 (7)	Sharp (Japan)	1050	2.8	3.0	5.4
7 (11)	JA Solar (China)	994	2.4	2.8	3.2
8 (12)	Jinko Solar (China)	923	2.3	2.6	4.6
9 (6)	SunPower (USA)	912	2.8	2.6	-
10 (10)	Hereon Solar (China)	888	2.5	2.5	-
10 (8)	Hanwha SolarOne (Korea)	750	2.7	2.5	3.3
12 (14)	Kyocera (Japan)	746	1.9	2.1	3.1

Note 1: Figures in parenthesis show performance in 2011.

Note 2: Based on 35.5GW produced in 2012 and 38.7GW in 2013.

Source: Author compilation in reference to RENS21 (2013) and http://www.statista.com/statistics/269812/global-market-share-of-solar-pv-module-manufacturers/

Table 11-2 Global Top Ten Polysilicon Manufactures in 2011

Rank	Company	Capacity (tons)
1	GCL (China)	65,000
2	OCI (Korea)	65,000
3	Hemlock (USA)	43,000
4	Wacker (Germany)	33,000
5	LDK (China)	25,000
6	REC Group (Norway)	19,000
7	MEMC (USA)	15,000
8	Tokuyama (Japan)	9,200
9	LCY (Taiwan)	8,000
10	Woonglin (Korea)	5,000

Source:
http://www.solarpowerworldonline.com/2013/04/top-10-solar-pv-module-suppliers-of-2012/ (accessed July 29 2013).

Table 11-3 Top 10 Wind Turbine Supplies in 2011-13

Rank in 2011	Company	Delivery in 2011 (MW)	Delivery in 2013 (MW)	Global Market Share (%)			
				2010	2011	2012	2013
1	Vestas (Demark)	5,211	4,850	14.8	12.7	14.0	13.1
2	Sinovel Wind (China)	3,700	-	11.1	9.0	3.2	-
3	Goldwind (China)	3,584	3,600	9.5	8.7	6.0	11.0
4	Gamesa (Spain)	3,308	1,951	6.6	8.0	6.1	5.5
5	ENERCON (Germany)	3,203	3,657	7.2	7.8	8.2	9.8
6	GE Energy (USA)	3,170	2,342	9.6	7.7	15.5	6.6
7	Suzlon (India)	3,116	2,239	6.9	7.6	7.4	5.3
8	Guodian United Power (China)	3,042	1,419	4.2	7.4	4.7	4.0
9	Siemens (Germany)	2,591	2,587	5.9	6.3	9.5	7.4
10	Minyang Wind Power (China)	1,500	1,242	-	3.6	2.7	3.5

Note: Figures in parenthesis show performance in 2011.

Source: Author compilation in reference to REN21 (2013; 2014) and http://www.cleantechinvestor.com/portal/wind-energy/10502-wind-turbine-manufacturers-global-market-shares.html (accessed July 29 2013).

Table 11-4 Global Top Ten Solar Cell Manufacturers by Capacity in 2011

Rank	Company	Capacity (tons)
1	Suntech (China)	2,400
2	JA Solar (China)	2,100
3	Trina Solar (China)	1,900
4	Yingli (China)	1,700
5	Motech Solar (Taiwan)	1,500
6	Gintech (Taiwan)	1,500
7	Canadian Solar (China)	1,300
8	Neo Solar Power (Taiwan)	1,300
9	Hanwha SolarOne (Korea)	1,100
10	Jinko Solar (China)	1,100

Source: http://energydeals.wordpress.com/2011/12/24/list-of-solar-companies/

http://pv.energytrend.com/research/20140129-6134.html (last accessed August 22, 2014).

Table 11-5 Share of Renewable in Electricity Generation

	2000	2005	2006	2007	2008	2009	2010	2011	2012
South Korea	0.04	0.11	0.13	0.20	0.31	0.40	0.90	1.53	1.69
China	0.05	0.26	0.19	0.34	0.67	1.24	1.88	1.91	2.62
Japan	0.60	0.89	0.92	0.96	0.99	1.10	1.14	1.39	1.64
Taiwan	0.00	0.04	0.15	0.24	0.29	0.45	0.47	0.74	N.A.
Philippines	25.65	17.51	18.52	17.22	18.08	16.79	14.78	N.A.	N.A.
Indonesia	2.66	5.18	5.00	4.94	5.55	5.86	5.86	N.A.	N.A.

Note: Taiwan includes only wind and solar power, while others include geothermal, biomass and waste power.

Source: Author compilation from the information in Japan Electric Power Information Center (2012); China Statistical Press (2013); Agency for Natural Resources and Energy, Japan (2014a; 2014b); United Nations (2013); Taiwan Power Corporation (2007; 2008; 2009; 2010; 2011; 2012), and Korean Energy Statistics Information System http://www.kesis.net/flexapp/KesisFlexApp.jsp?menuId=Q0109&reportId=&chk=Y (accessed on August 21, 2014).

Table 11-6 Recovery rate of electricity price by sector in South Korea in 2007

Sector	Recovery rate
General	108.4
Residential	99.2
Industrial	90.5
Educational	88.7
Agricultural	39.2
Average	93.8

Source: Author compilation from Jones, R. S. and B. Yoo (2011).

Table 11-7 Gross Margin of PV Modules in the First-Tier Chinese Supplier in 2012

Company	Net loss (US$ million)	Gross Margin
Canadian Solar	-3.9	0.10
Jinko	-20.8	0.13
JA Solar	-33.3	0.06
Hanwha SolarOne	-36.4	0.03
ReneSola	-39.0	-0.02
Trina	-63.7	0.02
Yingli	-103.4	0.04

Source: 'Canadian solar's 1Q13 financial result evaluation: Rise in gross margin lead to decrease in loss,' *Energy Trend* July 4, 2013. http://pv.energytrend.com/research/20130704-5379.html (accessed July 24 2013).