SYSTEM INNOVATION: CASE STUDIES

KOREA – Green innovation and systemic changes

OECD

Case Study of Korea
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Green Innovation and Systemic Changes in Korea

1. Introduction

This chapter will trace systemic changes in Korea from 2008 when the nation started pursuing green growth to recent days, as a case of system innovation. On the one hand, such changes developed rapidly by taking advantage of the nation's characteristic and strength like state-oriented policy planning and implementation. On the other hand, they were propelled by the nation's keeping up with the global, simultaneous shift towards earth-friendliness and environment-friendliness and leading green growth strategies.

From the perspective of system innovation, systemic changes investigated in this case study are summarized in three areas shown in Table 1. In the meso-level, functional systems were materialized with low carbon green energy systems. In the supply perspective, experiments on new systems were conducted, while as for demands public-private programs led to changes in consumption and industry. Radical technological innovation supporting these changes included such elements of the government's R&D policy support and the introduction of green technology, product, and SME certification systems. In the macro-level, the Korean government promoted its green growth policy by supporting government-wide governance and national programs.

Table 1. Multi-level perspective for analyzing green system innovation in Korea

	Meso level of functional systems	**Radical technological innovation**	**Macro-level & broad external environment**
	Low carbon green energy system	Green technologies(esp., new and renewable energies)	National Strategy for Green Growth
Supply push	Test-beds Experiments	Green technology R&D programs	Green Campaign Green Education
Demand pull	Support of private demand Green home & building New energy plants	Green certifications (techs, products, SMEs) Tax incentives	RPS(Renewable portfolio standard)
Coordinated Approached	• Renewable energy power introduction • Low carbon green town program • Smart Grid Test-bed	• Lead markets (esp., export orientation) • Regional innovation system operation • Multi-institutional cooperation	• Green growth program • Whole-of-government approach coordination committee (Presidential Committee for Green Growth)

Such a multifaceted approach assisted the nation, which had been an outsider in discussions over climate change, in being a leader in green-technology-based systemic transitions. Efforts for the green transition have been prevailing across society, including individuals, businesses, industries, civil societies, and regions.

Nevertheless there remain many factors that hinder the nation's green transition. Among others, low energy prices and shale gas development serve as an obstacle against the expansion of renewable energy power plants, and small and medium enterprises have difficulties in market creation and competition based on supply-led green technological innovation. Ensuring the maturity of non-government organizations related to the green transition and promoting government-led national programs in cooperation and partnership with civil societies remain important policy challenges.

2. Shaping Green System Innovation

The 'big picture' of the green system innovation was provided in a strategy developed by the Presidential Committee on Green Growth (PCGG) in 2009, which aimed to cope with climate change and develop green innovation and industry as new growth engines. The strategy was developed as a government-wide national plan from the beginning and clearly provided viable transition goals and methods for each area of the green system.

From the perspective of the establishment of a green regime, the green growth strategy assisted in creating momentum for systemic innovation by presenting directions for the green transition in functional areas. The areas of the green regime can be divided into: 1) politics and policy; 2) business and industry; 3) society and culture; 4) science and technology; and 5) market and consumption. Although the starting points and levels of change vary by area, these areas have proceeded towards the establishment of a huge green regime in the last seven years.

Table 2. Areas comprising the green regime and major changes in each area

Area of the green regime	Major changes
1. Politics and policy	Strong political leadership for green growth; continued expression of political support; green growth strategy; establishment of public and international organizations for green growth.
2. Business and industry	Greening of production; expansion of green innovation; green brand establishment.
3. Society and culture	Energy saving, green education and other changes in daily lives; increases in NGOs for the green transition; green transition campaigns promoted in the local community level; improved recognition of the public for climate and environmental change.
4. Science and technology	Expansion of green technological R&D; promotion of ICT development from green innovation perspectives.

5. Market and consumption	Increased added values of green products and purchase power; customized resource-saving service.

The green growth strategy had a holistic approach that connected among the areas of the green regime to help each policy measure work in these areas. According to the *Green Growth Evaluation Plan* in 2010, 26 of 36 central governmental ministries and agencies conducted green growth policy programs (PMO & PCGG, 2010). Given that before 2008 environmental policy and renewable energy policy had been partially covered by only few government agencies such as the environmental and industrial ministries, the government-wide approach after 2009 was a critical change in governance.

Establishing a green regime meant various players were involved in green systemic innovation processes, thereby making a huge change. In the early stage of the promotion of national programs for green growth, the government, the public sector, R&D institutes, and businesses were the key players in the green alliance. In the course of the establishment of the green regime, civil society became increasingly interested in it and local communities and NGOs voluntarily initiated their own moves for the green transition. Following these changes, green issues, which had been discussed only within the domain of environmentalism, developed into national agenda for green growth and issues for a sustainable future in civil society.

Of note, stakeholder groups grew and systemic problems emerged in the course of Korea's green systemic innovation. As policy and programs on green growth were managed in the state level, debates on the scope of green growth and detailed areas were arisen. An example is the Four Major Rivers Restoration Project. Initially the project was intended to introduce canals modeling after Europe but later revised as a river maintenance project to improve adaptability to climate changes. The project had no continuity and was finished eventually. Businesses had high expectations for market creation during the years of green growth promotion, but many have had difficulties in continuing investment in green innovation as the development of domestic and global markets has been gradual. The government's strong drive towards green growth enabled swift adaptation to change and formation of an efficient implementation mechanism. But over time necessity to have more stakeholder groups such as local residents involved in policy establishment has emerged.

Despite these problems, the public had very positive recognition of green growth and civil societies became increasingly involved. Although the government, businesses, and civil society had different recognition of the green systemic transition (Yun and Won, 2012), more than 80% of the respondents to a survey of 1,000 people answered that the green growth strategy contributed to coping with climate change and overcoming the energy crisis, and more than 90% maintained that the green growth strategy should continue (PCGG, 2013).

3. Drivers of Systemic Change and Barriers

The drivers of changes enabling green systemic innovation are divided into external and internal factors. External factors are mega-trends that drive systemic changes and extreme shocks for example increasingly fierce competition in domestic and international markets. Internal factors are conducts of doers in systemic innovation to create connections between areas.

The direct external factor that contributed to the establishment of the green growth strategy in Korea was the global financial crisis that was initiated in the US in 2007 and spread to the Europe, and subsequently to Korea in 2008. The global financial crisis led to a decrease in the nation's per capita GNI from 21,695 US dollars in 2007 to 19,296 in 2008 and 17,193 in 2009. Also, after the nation joined the league of advanced countries, it faced with increased demands to take part in international cooperation activities to cope with climate change. Such macroscopic drivers urged for fundamental improvement and new growth engines for the Korean economy. To cope with such a crisis, the green growth strategy was planned in 2009 as a national framework for adaptation to climate change and economic development.

Internally, microscopic drivers for eco-friendly green transition worked in the political, media, economic, social, and infrastructure fields. Politicians adopted the "green new deal" as the only pathway for an economic rebound, and the key policy of the central and local governments put green growth at the front line. Media propagated "green- or eco-" campaigns, resulting in that people became increasingly interested in green certificated/labeled products. As financial support for green consumption and green businesses, tax incentives, subsidies, public procurements, public services were expanded. Local communities covered the transition to low carbon green growth as their local issues, and technical and infrastructure projects to support the transition were promoted.

Change in role settings and innovation activities in the innovative system, among drivers to lead the systemic transition, was the most important. Geographically, Korea's higher education, national R&D, and industrial activities are mainly conducted in the regional level in Seoul, Daejeon, and Gyeongsang Province, respectively. Such geographically scattered innovation activities led to various programs such as national R&D programs, regional innovative cluster programs, new technology and system test bed and pilot run programs, etc. After the green growth strategy emerged, the doers of innovation activities set green innovation as their key mission in public organizations and private businesses, and new experiments were conducted in various regions through public-private cooperative programs.

As an example of how this innovative system worked, the wind power sector developed primarily in the Busan and Gyeongnam region, and subsequently wind turbines proliferated throughout the nation. Located in the southeastern part of Korea, the Busan and Gyeongnam region serves as home to large enterprises specializing in shipbuilding and machinery and SMEs supplying parts and materials to the large businesses. Propelled by the green growth strategy, traditional shipbuilders such as Hyundai Heavy Industries, Samsung Heavy Industries, Daewoo Shipbuilding and Marine Engineering,

Doosan Heavy Industries & Construction, HYOSUNG Power and Industrial Systems Performance Group pursued to develop wind turbines. They swiftly strengthened their technical capabilities by developing original technologies, acquiring foreign winder power companies, and making industry-academy technical cooperative partnerships and pioneered markets at home and abroad. Wind turbine specialty company such as Unison grew up as well. As shown in Figure 1, the sales revenues of Korea's wind power sector increased from $75 million in 2007 to $936 million in 2009, and the gross generation of wind turbines reached 448MW in 2012.

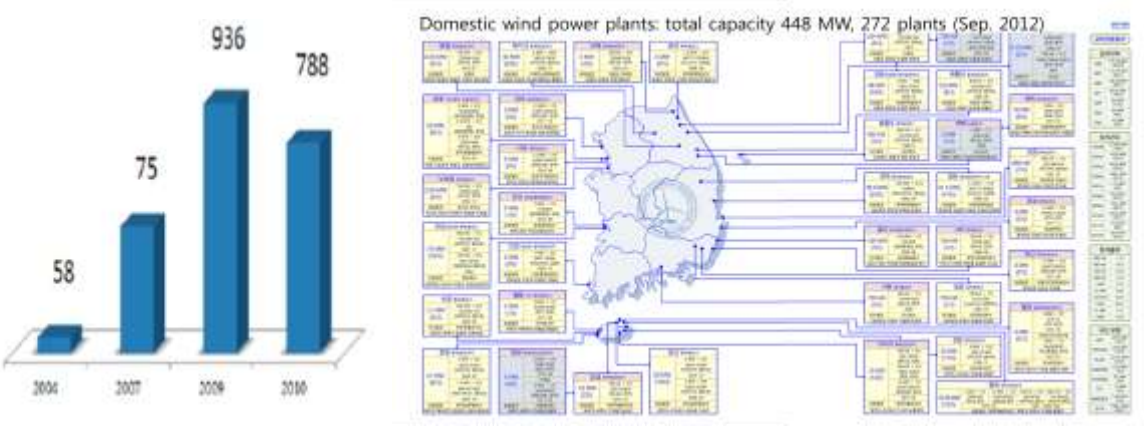

Figure 1. Annual sales of domestic wind power sector (mil. Dollars, left) and Domestic distribution of wind power plants (right) (Source: MKE & KEMCO, 2012)

There are barriers against continuing such a systemic transition. Green systemic innovation innately requires continuous long-term strategies, but political agenda and social interests change in the short term. In the state level, green growth has maintained its momentum powered by the organization of the second government-wide committee in 2013 and the development of the second green growth strategy in 2014. Electric energy price structure and shale gas development pose another barrier to the green transition. The production cost of renewable energies is still higher than that of the conventional energies, and shale gas plays as a momentum to stick to the existing carbon-based energy production system. In addition, the centralized power generation and distribution system makes it difficult to introduce new grid systems. Deterred by the outlook that grid parity will come after 2020, green companies are reluctant to make their steps towards the small, far-off green market.

4. Key Enabling Technologies

The International Energy Agency (IEA) suggested the following as core technologies for carbon dioxide reduction. According to this scenario, the active use of carbon capture and storage (CCS) technology, renewable energy, nuclear energy, and energy production efficiency improvement technologies would reduce CO_2 emissions after 2010 and on.

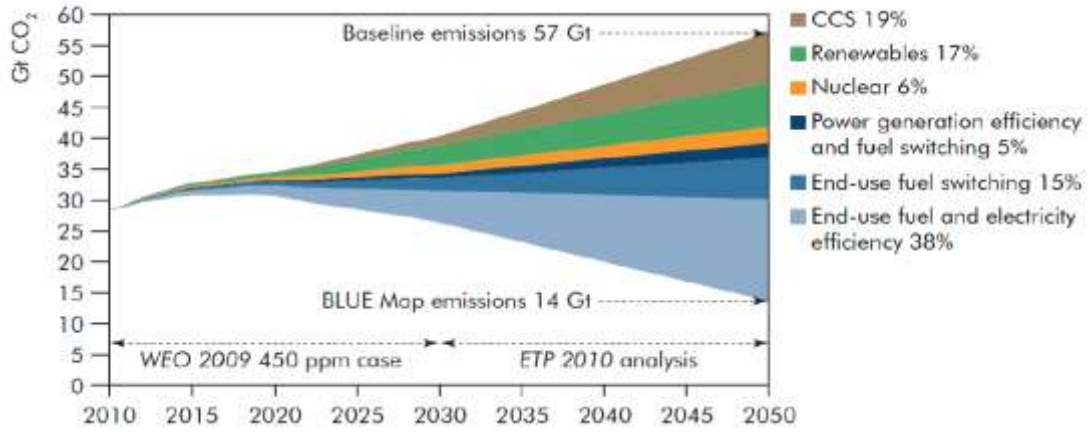

Figure 2. The IEA Blue Map Scenario's key technologies to reduce CO2 emission (Source: www.iea.org)

Korea's green growth strategy includes a variety of strategies to invest in internationally recognized CO_2 reduction technologies for example as provided in the IEA Blue Map. As shown in Table 3, the Korean government selected 27 core green technologies, for example climate change, energy source, energy efficiency, end-of-pipe, and virtual reality technologies, and has increased investment in these areas. Intriguingly, unlike the IEA Blue Map Korea's green technology list includes many IT-related items. This is suggestive that information technology has been reinterpreted as green technology in that it can reduce humans' physical movements and the consumption of resources. In Korea, there is a propensity to expect that many IT-based "Smart" technologies would contribute to resource and energy savings.

Table 3. Core green technologies

Sector	27 core green technologies
Climate change	1. Monitoring and modelling for climate change 2. Climate change assessment and adaptation
Energy source technology	3. Silicon-based solar cells 4. Non-silicon based solar cells 5. Bio-energy 6. Light water reactors 7. Next-generation fast reactors 8. Nuclear fusion energy 9. Hydrogen energy R&D 10. High-efficiency fuel cells
Technologies to improve efficiency	11. Plant growth-promoting technology 12. Integrated gasification combined cycle 13. Green cars 14. Intelligent infrastructure for transport and logistics 15. Green city and urban renaissance 16. Green buildings 17. Green process technology 18. High-efficiency light-emitting diodes/green IT 19. IT-combined electric machines 20. Secondary batteries
End-of-pipe technology	21. CO_2 capture, storage and processing 22. Non-CO_2 processing 23. Assessment of water quality and management 24. Alternative water resources 25. Waste recycling

	26. R&D in monitoring and processing for hazardous substances
R&D in virtual reality	27. Virtual reality

(Source: PCGG, 2009)

Following the selection of the green technologies, the government has increased investment in green R&D. While in five years since 2008 the government's R&D investment increased by 9.7% annually, investment in green technology R&D increased by 16.8% a year, and the average annual increase in investment in target green technology R&D was 18.3%. This suggests that the government has intensively developed green technology.

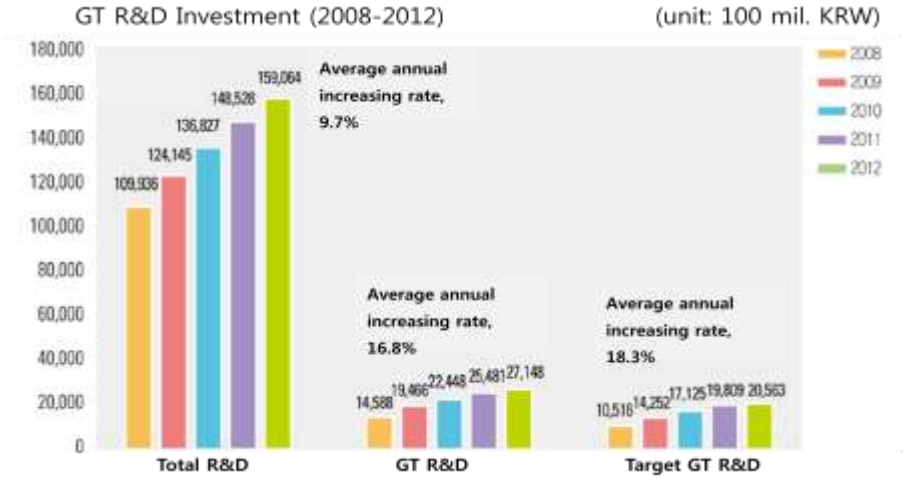

Figure 3. Recent trend of government R&D investment for green technologies (2008-2012) (Source: MSIP & GTC, 2013)

Testing out developed technologies is as important as facilitating R&D. Korea applies the CCS technology to post-processing of power generation. The wet plant technology was introduced in 2010, and a dry plant was constructed in 2014. A pilot project on an energy-efficient grid system is in progress. The private-public partnership for the construction of the Jeju Smart Grid Test-bed Complex was established in 2009, and the Smart Grid Roadmap was developed to expand smart grids. In 2011, the Shihwa Tidal Plant was constructed as a new energy plant, and the tidal power plant construction plan for other coastal areas was established with an aim to promote tidal power generation.

5. Governance for Green System Innovation

The government and the public sector used not to be interested in environmental issues before the green growth strategy. In those days, the environmental ministry primarily took responsibility for environmental policy, and other ministries promoted only few policy programs.

The very first change following the green growth trend occurred in policy governance. The Presidential Committee for Green Growth was organized under the direct control of the president, and the Basic Act on Low Carbon Green Growth was established to build an implementation mechanism for the government-wide approach to green growth. Most government ministries including the Ministry

of Strategy and Finance developed green growth action plans and promoted policy programs in their areas, of which results were evaluated by the PCGG's green growth assessment and feedback applied to the ministries' next year action planning.

Businesses' transition to green growth merits mention. Many companies participated in the green growth strategy promoted by the government and the public sector and incorporated the green agenda in their visions and strategies. For example, the world-renowned steel company POSCO expressively declared its dedication to low carbon green growth through its corporate mission statement in 2010 and subsequently expanded its business to green buildings, green homes, and green construction material fields.

Civil societies did not put their trust in the government's green policy in the early stage of green growth attributable a few controversial issues such as the Four Major Rivers Project and nuclear power generation. However, they became increasingly involved in many areas that green growth covered. There are increasing community-level efforts for the green systemic transition and civil societies' green transition monitoring activities with regard to climate change adaptation and carbon dioxide reduction.

6. Role of Innovation Policies

Innovation policy to facilitate the green systemic transition has been promoted twofold: one in the supply side, and the other in the demand side.

Key policy measures used in the supply side included the following:

1) Increase of government R&D expenditure for green technologies, twice increase for 5 yrs (2008-2012).
2) Selection of 5 target areas and 27 strategic technologies in the green technology field to improve the efficiency and concentration of technical development.
3) Government certification for green technologies, green products, and green SMEs. From May 2010 to April 2014, about 1,590 technologies were certified as green ones (400 techs certification per year).
4) For companies having green tech certification have advantages to get general loan of green growth, policy loan based on green credit and governmental guarantee for green high tech companies.
5) Encouraging nationwide regional systems of innovation and innovation clusters to set green innovation as their vision.

Key policy measures used in the demand side included the following:

1) Eliminating FIT (feed in tariff, ~2011) regulations and introducing the RPS (renewable

portfolio standard, 2012~).

2) Green labeling for green products and high energy efficiency products.
3) Photo-voltanics, wind power, fuel cell and smart grid test-beds for technical transfers and applications.
4) Support of private demand: tax incentives and infra supports for green car, direct subsidy and after service for green home, and energy efficiency (energy saving) labelling for green electronics.
5) Green construction projects through PPPs: green town, green home, green building.

Abbreviations

PCGG: Presidential Committee on Green Growth
MKE: Ministry of Knowledge Economy
KEMCO: Korea Energy Management Corporation
GTC: Green Technology Center
MSIP: Ministry of Science, ICT and Future Planning

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