

KEY POINTS

- Green transition demands transformative innovations in the economy and society. Tertiary education institutions in the Republic of Korea are actively engaged in expanding their green innovation activities.
- The central government has initiated incentive programs to encourage higher education institutions to develop interdisciplinary green education and research courses.
- Universities have formed strategic partnerships with private businesses and created industry–university collaborative education courses and research and development to respond to the future needs of human resources and green technology.
- To facilitate technology commercialization, universities have enhanced start-up–incubating systems by establishing technology–holding companies and other mechanisms.
- Local governments and local campuses are cooperating to develop new regional economic growth engines as the green transformation results in the phasing out of gray industries and the promotion of green businesses and investments.

The Role of Tertiary Education for Green Transition: Initiatives in the Republic of Korea

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BACKGROUND AND PURPOSE

In June 2022, the Council of the European Union adopted the recommendation on “Learning for the Green Transition and Sustainable Development.”¹ This is a key policy highlighting the crucial role of education and training in helping to achieve the goals of the European Green Deal. Along with Europe, other regions and countries are grappling with the threat and impact of climate change. They are now examining the critical role that education—including tertiary education—can play in devising strategies, developing technology, and reskilling, upskilling, and “greenskilling” the workforce.

In the Republic of Korea (ROK), human resource development has been an engine of economic growth, with tertiary education contributing significantly to technology-intensive innovation and industry transformation since the 1960s. Recognizing the importance of transitioning to a low-carbon and climate resilient economy, the government has recently advanced green development strategies, targeting the achievement of carbon neutrality by 2050 and investing in low-carbon activities.

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¹ European Union Law. 2022. Commission Staff Working Document Accompanying the document Proposal for a Council Recommendation on learning for environmental sustainability; European Commission. 2022. Learning for the green transition and sustainable development. 16 June.

The government is also strengthening its support for vulnerable groups and regions—recognizing that carbon-intensive industries will decline, green industries will rise and occupational and skills demands will need to change.

In this context, higher education institutions, with support from government, are making advances in three key areas. First, they are changing curricula and offering more green-focused courses and degree programs. Second, they are conducting research and development (R&D) on new technologies to address climate change. Third, they are working with the private sector to commercialize green innovation, including through the incubation of green technology (green-tech) start-ups. The government is aware that climate change and the greening of the economy may exacerbate local and regional disparities in economic opportunity. As such, the national government has launched several initiatives to help local governments partner with local universities to devise and implement green development schemes.

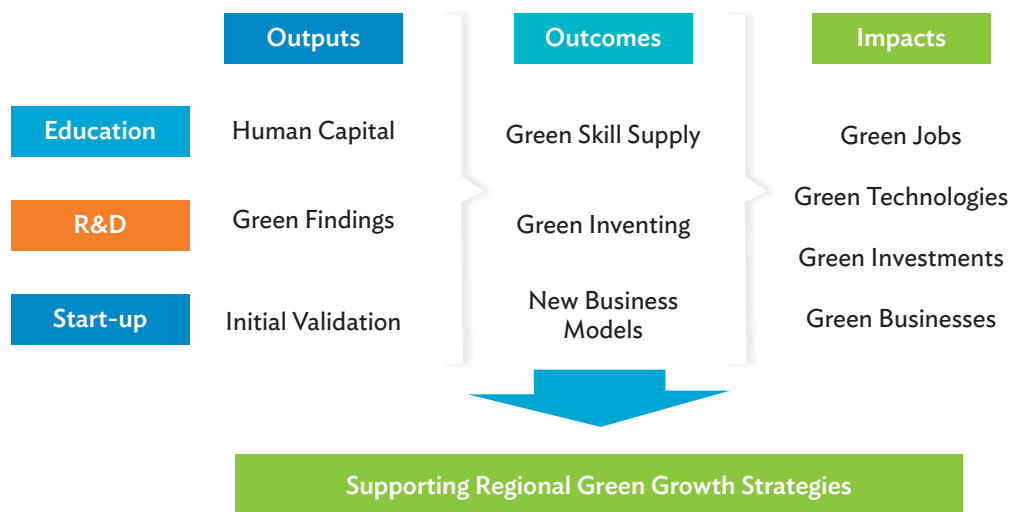
This *ADB Brief* outlines the initiatives being undertaken by the ROK to utilize the tertiary education sector in the fight against climate change and the achievement of an inclusive green transition. Starting with an overview of the Korean New Deal, the brief is structured around three key areas: curricula, R&D, and commercialization. A latter section discusses local green development schemes. Most of these initiatives have been implemented only recently and therefore their effectiveness has not yet been assessed. Nonetheless, they provide valuable insights for other countries in the Asia and Pacific region that are thinking of ways to deploy tertiary education in creating a greener future.

THE KOREAN NEW DEAL AND WORKFORCE PLANNING

The first version of the Korean New Deal was announced in July 2020. Since then, the government has upgraded and elaborated further its green transition schemes. The Long-Term Workforce Demand Outlook 2020–2035: Reflecting Digital and Low-Carbon Transformation was subsequently released based on the New Deal. The outlook provides industry-specific, long-term workforce demand forecasts. Subsequently, the Korean New Deal 2.0 was adopted in July 2021 and the Carbon Neutrality and Green Growth Act was approved in August 2021, after comprehensive national consultation.

The Korean New Deal 2.0 emphasizes human resource development and includes the “Human New Deal” as a critical pillar of the plan. The Human New Deal supports the development of high-quality human capital, including the skills and education needed for future industries to tackle climate change mitigation and adaptation.² It also includes a just transition scheme with a social and employment safety net for people affected by economic and job restructuring. These high-level policies support, or include, government programs in the three key areas of curricula, R&D, and commercialization (Figure 1). The role of universities in the green transition is supported not only by the Ministry of Education but other ministries as well (Table 1).

Figure 1: Impact Pathway of University Education for Green Transition



R&D = research and development.
Source: Author.

² Government of the Republic of Korea, Ministry of Economy and Finance. 2021. Government Announces Korean New Deal 2.0. Press release. 14 July.

Table 1: Major Ministries’ Green Policies for Tertiary Education in the Republic of Korea

	Ministry of Science and ICT	Ministry of Environment	Ministry of Industry
Policy	Carbon-neutral technological innovation promotion strategy	4th Environmental Technology, Industry, and Human Resource Development Plan	Energy technology human resource development measures for carbon neutrality
Start Year	2021	2018	2021
Field	Carbon-neutral technology	Environmental technology	Energy technology
Key Points	<ul style="list-style-type: none"> • Selection of 10 core technologies and development strategy • Promotion of cross-ministerial R&D • Commercialization of public sector-driven technologies • Private-led cooperation • Advancement of sustainable R&D, and higher education system 	<ul style="list-style-type: none"> • Innovative growth of the environmental industry and market • Fostering future human resources geared toward the environment, and strengthening support for activities • Enhancement of infrastructure integrating technology, industry, and human resource development 	<ul style="list-style-type: none"> • Education and training of talents leading energy convergence and innovation • Development of a human resource supply system that responds to the industrial and energy transition • Enhancement of human resource training performance and strengthening feedback

ICT = information and communication technology, R&D = research and development.

Source: E Y. Jung, G.Choi, S. Han, T. Kim. 2022. Korea Policies for Human Resource Development in the Climate Technology Area. GTC Brief. 3(4).

CURRICULUM: INTERDISCIPLINARY AND CONVERGENCE IN EDUCATION

To facilitate the transition to a green economy and equip future workers with the knowledge and skills necessary to navigate the challenges of the new green economy, universities must instruct and train students in complex and converging subject matters. Like many other developed nations, universities have expanded their interdisciplinary green science and technology programs.

The Ministry of Environment operates the Specialized Graduate School for Climate Change Program, which supports the development of cross-sectoral curricula at graduate schools. Since 2016, the ministry has provided funds to 17 universities. For instance, the program has supported Kyung Hee University (KHU) to operate the Department of Convergence Science and Technology in collaboration with the Korea Institute of Science and Technology (KIST). The goal is to nurture professional research talent and generate world-class research. Since 2018, KHU has operated the Climate Change Specialized Graduate School, which focuses on intelligent-based, consumer-tailored climate change risk assessment and adaptation research. Students are provided with learning research opportunities and with support such as scholarships, research incentives, global internships, and student exchanges with foreign universities.

The Ministry of Science and ICT has initiated a Climate Technology Researcher Training program to support partnership-driven research and development skills acquisition.³ The campuses selected for this training program design an interdisciplinary and

cross-sectoral master’s degree program on climate technology development practices.⁴ During the 18-month program, students work with professional mentor groups, professors, and commercial experts on R&D activities.

The Ministry of Education supports the Innovative Convergence University Project that enables students to pursue education in high-tech field by removing barriers between universities. Started in 2021, the project has supported education in critical new technology fields such as artificial intelligence, big data, new energy industries, future automobiles, biohealth, and others. The participating universities create a consortium in which they participate together in curriculum and course development (Figure 2). Each university’s lectures and laboratories can be accessed by students from the other participating universities.

For example, the New Energy Industry consortium is composed of seven universities including Korea University, Hanyang University, Pusan National University, and so on, and provides education on production, storage, transfer, utilization, and management of energy through a shared modular curriculum (Figure 2). Theory lectures are provided online and laboratory instruction is provided in specialized laboratories in the seven participating universities.

³ Government of the Republic of Korea. *Announcement of integrated new tasks for the 2022 Science and Technology Innovation Talent Training Project.*

⁴ In 2022, Inha University was selected for its hydrogen technology curriculum, and Korea University for its focus on energy, environment, and climate technology.

Figure 2: Modular Curriculum of the New Energy Industry Consortium (7 universities)

	Energy production	Energy Storage/ Conversion	Energy Transport/ Management	Energy Management
BG elective	<ul style="list-style-type: none"> Introduction to New Energy Engineering Introduction to Renewable Energy Engineering Introduction to Hydrogen Fuel Cells 	<ul style="list-style-type: none"> Introduction to Energy Storage Engineering Introduction to Energy Materials Electrochemical Energy Storage Theory and Experiments 	<ul style="list-style-type: none"> Introduction to Electrical Energy 	<ul style="list-style-type: none"> Economics of Energy and Technology Energy & Environment Technology Energy and Climate Change
IM major	<ul style="list-style-type: none"> Energy Response Engineering Energy Production Materials Engineering Biowaste Energy Engineering 	<ul style="list-style-type: none"> Energy Storage Redesign Giant Energy Storage Zero Energy System 	<ul style="list-style-type: none"> Next-generation power electronics and electrical equipment Chemical Energy Transport AI Infrastructure Energy Management 	<ul style="list-style-type: none"> Energy Statistics Big Data Analysis Energy and Climate Change Policy AI-based energy safety engineering
AD major	<ul style="list-style-type: none"> Solar Energy Engineering Geothermal Energy Engineering Wind Energy Engineering Hydrogen Energy Engineering 	<ul style="list-style-type: none"> Electric Vehicle Battery Engineering Next-generation energy conversion engineering Fuel cell Heat pump 	<ul style="list-style-type: none"> Wireless energy transfer AI-based system optimization Smart Grid 	<ul style="list-style-type: none"> Energy Business Feasibility Assessment Research on new energy business issues

AD = advanced, IM = intermediate, BG = beginning.

Note: The consortium is composed of seven universities including Korea University, Hanyang University, Seoul National University, Pusan University, Kangwon National University, Chunbuk National University, Kyungnam College of Information & Technology and designated by Ministry of Education of Republic of Korea.

Source: Author, Presented ADB International Skills Forum 2023.

A variety of degree programs are offered, including micro-degree, minor degree, convergence major, and double major. In 2022, the second year of the project, about 5,000 students took courses.

Green transformation requires some companies to change the goods and services they produce. In the manufacturing sector, companies can foster a green-tech workforce to develop green technologies and make green products. High-tech companies, such as LG and Samsung, have cooperated with universities and have agreements to operate professional R&D capacity programs.

Companies indicate that lack of green-tech talent is a severe constraint for them to expand their sales of green products.⁵ A stable supply of green-tech workers through cooperative tertiary education programs can help companies facilitate the commercialization of green products and services. In 2021, LG Energy Solution, a major battery maker, and Yonsei University agreed to launch collaborative interdisciplinary master’s and doctoral programs on secondary batteries.⁶ For this program, LG provides scholarships, living expenses, and internship opportunities to develop work-ready graduates to address the sector’s critical labor shortage.

RESEARCH CAPACITY ON GREEN TECHNOLOGY

Through R&D activities, tertiary institutions contribute to green technological advancements and commercialization of these technologies (see next section). The government has chosen 100 core technologies that can help the country become carbon neutral. These include heat pumps that use water and air to generate heat, a green method for making steel using hydrogen instead of coal, and zero-energy buildings that use only new and renewable energy sources⁷(Figure 3). In January 2022, the Ministry of Science and ICT named the Korea Institute of Energy Research as the Climate Technology Policy Support Center and the National Institute of Green Technology as the Climate Technology Cooperation Policy Support Center.

Some universities have been designated as national research centers and are part of the platform for developing technologies. Top universities are now working together to develop technology, and the collaboration among universities, research institutes, local governments, and businesses has been strengthened to support

⁵ Republic of Korea, Ministry of Environment. 2023. *Eco-Up Talent Development Strategy*.

⁶ Secondary batteries, often called rechargeable batteries, can be used, discharged, and then restored to their original condition by reversing the current flow (charging).

⁷ Jin-Won Kim. 2023. S.Korea selects 100 core technologies to achieve carbon neutrality. *The Korea Economic Daily*. 23 May.

Figure 3: 100 Key Technologies for the Carbon Neutrality of the Republic of Korea

Solar energy	Ultra-high-efficiency solar-cell technology	Zero energy building	Super-insulation covering material and facility technology	
	Diversified uses of solar power technology		Green remodeling technology	
	Wasted solar power recycle technology		Building refrigeration and air-conditioning efficiency technology	
Wind power	Supersized wind turbines technology		Building energy system efficiency technology	
	Offshore wind power floater technology		ESS convergence technology using renewable energy	
	Technology to operate and manage offshore wind power plants		Fuel cell-based convergence system technology	
	Vertical axis type floater wind power technology		Unused energy usage technology	
Hydrogen supply	Technology to produce water electrolysis hydrogen		CCUS	Building energy data integration system technology
	Technology to produce water electrolysis hydrogen			Building energy smart linking control technology
	Technology to store and transport hydrogen overseas			Technology for piling up after combustion
Carbon-free energy	Hydrogen to gas turbine gas power technology	Industry processing piling up technology		
	Hydrogen combustion gas power technology	Technology for piling up during combustion		
	Dust coal boiler ammonia mixed fuel technology	Direct air piling up technology		
	Floater boiler ammonia mixed fuel technology	Land and sea storage exploration and evaluation technology		
	Ultra high-efficiency fuel cell compound development technology	Storage facilities design and establishment technology		
Power Storage	High-efficiency fuel cell cogeneration system technology	Storage CO ₂ injection and operation technology		
	Short-term ESS technology	Monitoring technology including storage leakage detection		
	Long-term ESS technology	Chemical conversion technology		
	After-use battery ESS system technology	Biological conversion technology		
Power Grid	Intelligent power transmission system technology	Carbon-free vessels	Mineral carbonation technology	
	Real-time electric power transaction platform technology		Internal combustion engine technology using carbon-free fuels	
	Technology to combine and operate distributed resources and flexible resources		Vessel fuel cell and battery system technology	
Energy integration system	Heat pump technology		Electric motor powered system technology	
	Solar heat technology		Technology of post-processing of carbon-free fuels and increasing efficiency	
	Power-thermal-hydrogen hybrid system technology			
	Thermal energy network system			

CCUS = Carbon Capture, Usage, and Storage, CO₂ = carbon dioxide, ESS = energy storage system.

Source : Carbon Neutral Green Growth Committee, 2023.

the green industry. Companies provide financial support, engage in expert consultations, and conduct joint research with universities. In return, they are able to secure high-quality human capital.

Seoul National University and the Korea Advanced Institute of Science and Technology (KAIST), in collaboration with the Carbon Neutral Green Growth Committee (cochaired by the prime minister) jointly organized a collaborative forum. Two eminent research universities have declared their intention to form a robust collaboration in the fields of carbon-neutral technology development and the cultivation of proficient experts in this domain.⁸

Samsung Electronics has implemented an organization-wide center for industry-academia cooperation. This center provides cutting-edge facilities to support research endeavors for university faculty, and doctoral and master's candidates. Additionally, it fosters the application for patent registration of collaborative projects between corporations and universities. Samsung Electronics and Korea University have constructed a collaborative eco-friendly e-research center whose primary objective is to conduct cutting-edge research on environmentally sustainable household appliance technologies of the future.

Hyundai Motor Group, in collaboration with five esteemed universities (e.g., the Korea Institute of Energy Technology and Hanyang University), has implemented the Carbon Neutral Joint Research Laboratory with the objective of investigating novel technologies that can capture carbon from the atmosphere and convert it into energy resources and valuable materials.⁹

COMMERCIALIZATION AND GREEN-TECH START-UPS INCUBATION

The government will invest \$107 billion in public-private partnerships by 2030 as part of its Strategy for Fostering the Climate Tech Industry (May 2023). Through its efforts, the government hopes to help foster 10 climate tech unicorn companies and generate 100,000 jobs in the sector. A specialized fund dedicated to high-tech manufacturing and emerging technologies is to be established. Additionally, it includes a strategy to encourage \$153 million in private funding to be used for corporate environmental, social, and governance (ESG) initiatives, including impact investing and corporate venture capital.

⁸ Seoul National University. 2023. Seoul National University and KAIST have joined forces to foster talent for carbon-neutral innovative technology! 19 May.

⁹ Dohyung Kim. 2023. Hyundai Motor Group joins forces with five domestic universities to research carbon-neutral technology. *Ferro Times*. 27 July.

Green-tech innovations and their commercialization are essential in green transformation and achieving carbon neutrality. As a result, Korean universities have extended their role from technology inventor to technology and start-ups incubator. In the last 15 years, many tertiary institutions have launched technology-holding companies¹⁰ to facilitate the commercialization of patents owned by the university. These holding companies help create business partnerships, enabling the tertiary education system to link with markets.

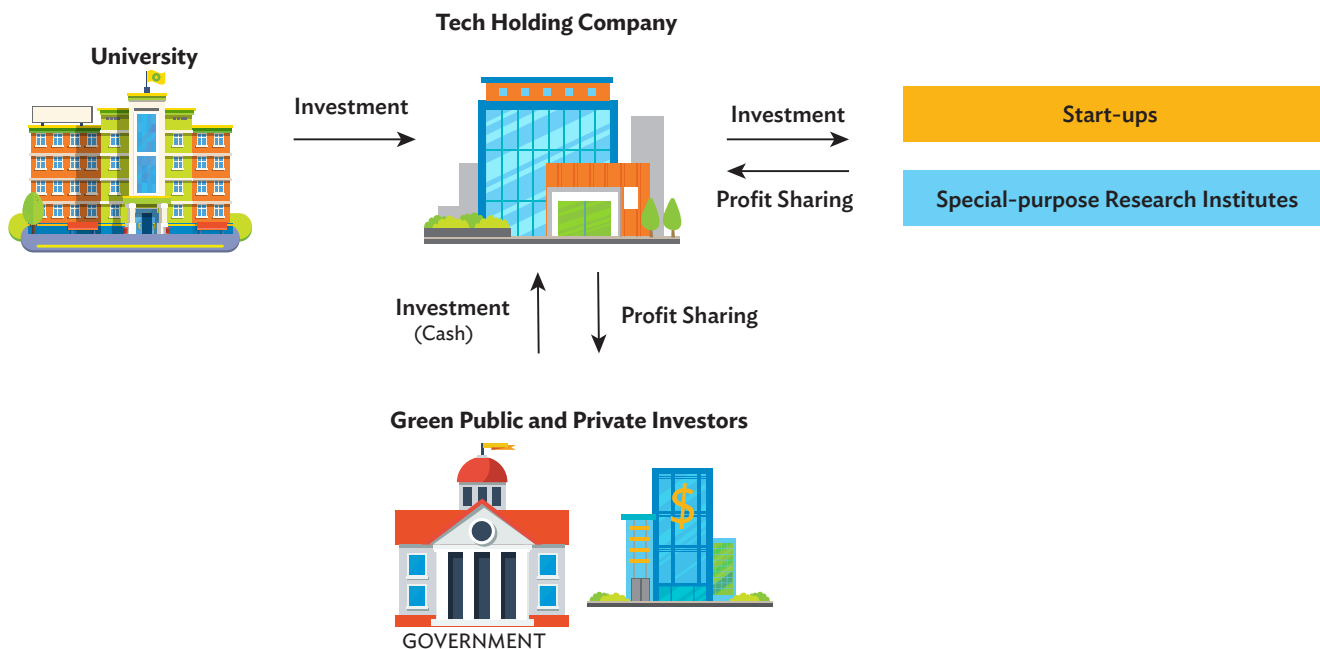
The government has assisted holding companies' efforts at commercialization by providing matching funds to boost the engagement of private investors. KAIST recently partnered with Hana Financial Group to support the development and commercialization of climate technologies. KAIST Holdings, a new technology holding company, and Hana Financial Group agreed to establish a research institute specializing in artificial photosynthesis technologies. Hana Financial Group's focus on environmental, social, and governance related investment objectives is expected to support KAIST's innovation capacity and facilitate the commercialization of high-end green-impact technologies. KAIST will adopt Hana's expertise to evaluate the financial viability of new green investment technologies.

Recently more universities have established Climate Tech Centers with the objective of fostering the growth of climate-tech start-ups. Universities are strengthening collaboration with venture capital investors and offering programs that provide climate-tech-related entrepreneurial education, consulting, risk assessments, and forums in response to the government's efforts to support climate-tech enterprises.¹¹

REGIONAL GREEN GROWTH STRATEGIES

The green transition can be a significant economic threat to regions where traditional gray and brown industry are being phased out. Local governments are implementing green development schemes to mitigate green transitional risks and maximize green economy growth. Local human resource development is often a core element of these schemes. Cities develop action plans in which universities integrate green-tech at their local campuses and supply a green-tech workforce to local industry. Based on these action plans, local authorities receive central government subsidies and mobilize private investment to build the capacity for green research and business development (R&BD).

Figure 4. Tech Holding Company by University

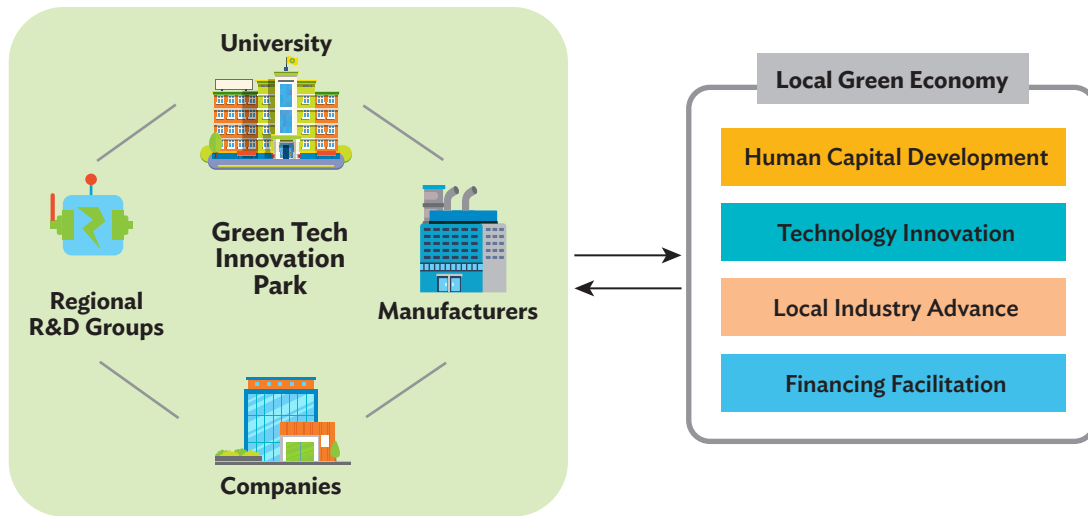


Source: Author.

¹⁰ The term “technology holding company” means a company that controls the company through the ownership of stocks (including shares) of other companies for the purpose of commercializing technology (Article 2 of the Act on the Promotion of Technology Transfer and Commercialization) owned by a university or research institute. This is a specialized organization for establishing and commercializing subsidiaries via technology investment (e.g., patents held by industry-academic cooperation, foundations, or research institutes).

¹¹ J. Kim. 2023. Seoul National University Climate Tech Center and Sopoong Ventures sign an MOU to revitalize climate technology.

Figure 5: Green-Tech Innovation Park



R&D = research and development.
Source: Author.

For example, Jeonnam Province is promoting investment in green growth areas. With access to ocean-based resources and infrastructure, it has set up an ambitious green growth strategy called the Blue Economy Development Plan. This encompasses renewable energy, biotech, low-carbon eco-tourism, intelligent aerial transport, climate-smart agriculture and fisheries, and green smart cities. The province is trying to mobilize high-end green technologies and it is positioning local universities at the heart of R&BD to incorporate innovative technologies and business models in its green development pathway.

Jeonnam University promotes green solutions in the energy sector that are financially supported by the provincial and the central governments. Through a national education investment initiative of the Ministry of Education, the university is founding the Campus Innovation Park—a future-leading energy tech R&BD hub of 22,000 square meters that integrates training, research, tech incubation, and venture investment for local enterprises.

Box 1: Regional Green Initiative in the United States and Indonesia

The University of California, Los Angeles (UCLA) partners with local entities to respond to climate change. Since 2015, UCLA has operated the Sustainable LA Grand Challenge, a green research partnership initiative to transform Los Angeles County to use 100% renewable energy and 100% local water and to create an enhanced ecosystem by 2050. The LA Grand Challenge connects UCLA's interdisciplinary intelligence and research assets with external partners and investors to equip the county with climate resilience and sustainability. This green initiative has mobilized research and development investment to innovate technologies, policies, diagnostic tools, and education tailored to local green transition needs.

In Indonesia, the National Research and Innovation Agency (BRIN) also links research innovation with regional green development. BRIN is transferring its green technology expertise to Indonesian cities to address urban sustainability challenges. BRIN's research structure and regional campuses enable its researchers and experts to be immersed in developing green technologies for regional economic and social needs. Recently, it has contributed to formulating Regional Research and Innovation Agencies (BRIDAs) to strengthen technology development and evidence-based policy making in the regions. Central Java, Bali and West Nusa Tenggara have established BRIDAs in coordination with BRIN. The BRIDAs and BRIN will collaborate with local research institutions and businesses to advance the research ecosystems.

Sources: UCLA: Sustainable LA Grand Challenge; BRIN: interviews with BRIN stakeholders, and several web-news such as (i) [BRIDA Talk, Communication Medium to Overcome Regional Problems](#); (ii) [BRIN Coordinates 3 Priorities for Strengthening BRIDA](#).

CONCLUSION

Tertiary education institutions are a pivotal actor in implementing the Korean New Deal, serving as a strategic pillar to achieve green transition. These institutions are addressing climate change adaptation and mitigation through various initiatives. The three areas are curriculum innovation (including interdisciplinary programs), green-tech R&D, and commercialization (nurturing of green-tech start-ups).

In the new energy sector, there is an increasing need for skilled personnel. To respond to new demands, the government has encouraged the reduction in barriers that exist between universities and university departments by expanding support for interdisciplinary and pioneering programs. Some programs provide innovative degrees and certificates that allow students to specialize in green technology and climate change issues.

Universities function not only as providers of education and skilled human resources but also as leaders in technological advancement via their R&D activities. Educational and research cooperation programs between universities and companies help to develop technologies for specific companies.

Furthermore, universities serve as incubators for nascent enterprises, facilitating preliminary verification and nurturing start-ups. Universities have strengthened their start-up incubation systems through the establishment of technology-holding companies and other mechanisms to facilitate the commercialization of technologies.

Universities collaborate with municipal and regional governments to develop and implement strategies for the expansion of the green economy at the local level. Universities are becoming important institutions in regional innovation ecosystems.

Korean universities can learn from their counterparts in other countries to better develop and define their role in the green transition. Likewise, universities in Asia's developing countries can learn from the Korean experience.

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