



INVESTMENT
OPPORTUNITIES
IN KOREA

Renewable Energy

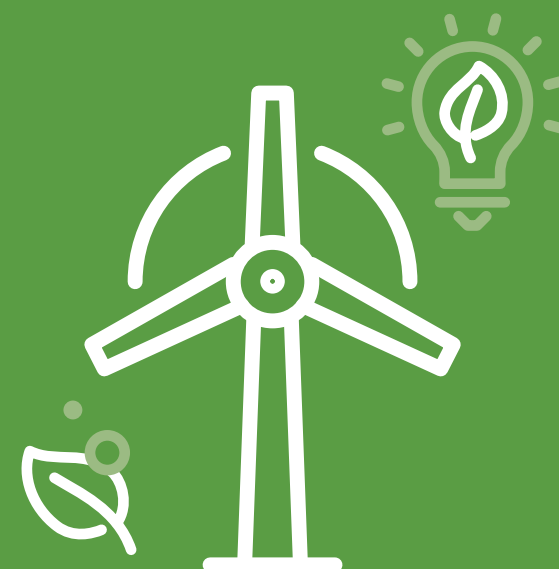


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Investment Opportunities in Korea _ Renewable Energy

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* Figures on the report show the likely adjustment of average yearly currency rates from Korean Won (KRW) to the US dollar (USD). A rate adjustment is adopted particularly reflecting the recent average market variations to eliminate the valuation effects arising from movements in exchange rates in case when the data expressed shows an annual growth rate on the paper.

* Rate adjusted figures are rounded off, but the sum is correct down or up to the decimal when the rounded values are not equal to the adjustment.

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01 Industry Trends

Definition and Scope

• (Definition) Article 2 of the Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy defines new and renewable energy as energy sources from which final energy (electricity, hot water, fuels, etc.) is derived and consumed using new and renewable fuels and equipment produced locally and abroad. The respective definitions of new energy and renewable energy are as follows:

- The term “new energy” refers to energy derived from the conversion of conventional fossil fuels or generated using electricity or heat from the reaction between hydrogen and oxygen, including hydrogen energy, fuel cells, liquefied or gasified coal, and gasified heavy residual oil (produced through such processes as the integrated gasification combined cycle (IGCC)).
- The term “renewable energy” refers to energy from the conversion of renewable energy sources, such as sunlight or water, including solar energy (photovoltaic, solar thermal), wind power, hydropower, marine energy, geothermal energy, hydrothermal energy, bioenergy, and waste-to-energy (WtE; excluding nonrenewable waste).

• (Scope) Along with manufacturing, power generation, construction, and services related to solar and wind and other renewable energy sources, industries such as energy storage systems, connection of distributed generation (DG) to a distribution grid system, as well as hydrogen fuel cells are also emerging as promising next-generation sectors.

- In spite of significant investment activities in new and renewable energy, basic industrial statistics are still lacking in Korea. As such, the Korea Energy Management Corporation publishes “New and Renewable Energy Industry Statistics” annually every end of September, based only on manufacturing data.

* A pilot survey with an extended scope, gathering data on sectors, including new and renewable energy supply, construction, and service industries, is currently underway as of 2019. The results are scheduled to be released in 2021 when time-series data become available, as per government-approved statistics.

1.1

Market Trends in Korea

Status of the supply of new and renewable energy

- In 2017, the newly installed new and renewable energy capacity amounted to an all-time high of 2.1 GW, of which 65.1% was solar PV, 23.3% was bioenergy, and 5.4% was wind power, from highest to lowest.
- As of 2017, the cumulative total installed capacity of new and renewable energy stood at 15.7GW, representing about 12.9% of total power generation capacity, with the largest share accounted for by solar PV (37.2%), followed by WtE (24.2%) and bioenergy (14.5%).
- In 2017, the share of new and renewable energy relative to total power generation amounted to 8.08%, and the share of renewable energy to total power generation was 7.6%. WtE accounted for the largest share of the total new and renewable energy power generation at 51.2%, followed by bioenergy (16%), solar PV (15.1%), hydropower (6%), and wind power (4.7%).

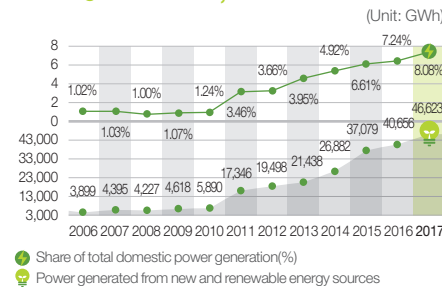
New and Cumulative Capacity and Power Generated by Type of New and Renewable Energy Source

Classification	Installed capacity/ power generation	Renewable energy						New energy	
		Solar PV	Wind power	Hydro-power	Marine power	Bio-energy	WtE	Fuel cells	IGCC
New	Installed capacity (MW)	1,362	114	6	-	487	90	33	-
	Share (%)	65.1	5.4	0.3	-	23.3	4.3	1.6	-
Cumulative	Installed capacity (MW)	5,835	1,143	1,794	255	2,284	3,794	251	346
	Share (%)	37.2	7.3	11.4	1.6	14.5	24.2	1.6	2.2
Power generated	Power generation (GWh)	7,056	2,169	2,820	489	7,467	23,867	1,469	1,286
	Share (%)	15.1	4.7	6.0	1.0	16.0	51.2	3.2	2.8

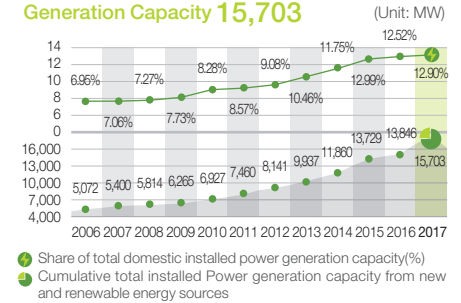
Source: "New and Renewable Energy Supply Statistics 2017" (Korea Energy Management Corporation (KEMCO), November 2018)

Cumulative Total New and Renewable Power Generation and Installed Capacity and Their Shares Relative to Total Power Generation and Installed Capacity

Power generation 46,623



Cumulative Total Installed Power Generation Capacity 15,703



Source: "New and Renewable Energy Supply Statistics 2017" (KEMCO, November 2018)

- Since the announcement of the New and Renewal Energy 3020 Implementation Plan (December 2017),* a key component of the current administration's energy transition policy, there has been an increase in the number of environmentally friendly energy-centered power generation facilities, with solar PV facilities leading the trend.

* Starting in 2018, a plan to progressively raise the share of new and renewable energy sources in total power generation to 20% by 2030 was made.

- In 2018, the newly installed capacity (provisional)* of new and renewable power generation amounted to 3,533 MW, a 69% increase from 2,092 MW from the previous year. Moreover, 2,367 MW was solar PV, corresponding to about 67% of the total new capacity, which is close to 1.7 times the solar PV capacity added a year earlier (1,362 MW).
- The cumulative total installed capacity of new and renewable power generation stood at 19 GW, representing 15.35% (provisional) of the total installed capacity of power generation (124 GW).
- In 2018, the total power generated from new and renewable energy sources amounted to 52 TWh (provisional), an 11.6% increase from the previous year, with the share of total power generation from all sources also increasing by 0.69% p to 8.77%. Meanwhile, the share of renewable energy in total power generation edged up by 0.58% p to 8.18%.

* "New and Renewable Energy Supply Statistics 2018," KEMCO (current as of the end of August 2019)

New and renewable energy industry (manufacturing) trends

- Growth in the new and renewable energy industry is expected to be largely driven by solar PV and wind power and hydrogen fuel cells.

- The Korean government released a plan to increase the share of renewable energy in total power generation from 7.6% in 2017 to 20% in 2030, as well as measures to promote the growth of renewable energy industries, including solar PV and offshore wind power.
- In the case of hydrogen fuel cells, the government plans to raise their production to 15 GW by 2040, a 60-fold increase from the amount in 2017, through measures laid out in the Roadmap for the Promotion of the Hydrogen Economy.

- A solar PV-centered energy market is rapidly taking shape, led by large corporations, such as Hanwha Chemical, LG, and OCI, and mid-sized firms, such as Shinsung E&G and S-Energy. In addition, there is a large lineup of SMEs, which will allow value chain-linked production across the entire value chain of solar manufacturing.

- As of 2017, the share of solar manufacturing in total new and renewable energy manufacturing stood at 26.0% in terms of the number of firms and 54.0% in the number of employees. Meanwhile, its shares in domestic sales, exports, and investment amounted to 47.6%, 85.1%, and 95.5%, respectively.
- With its per-unit cost of power generation falling faster than that of any other renewable energy source, solar PV is moreover considered the most effective for increasing small DG systems, which bodes well for solar manufacturing, which is likely to continue its upward trend.

* The per-unit cost of solar power generation dropped at an annual rate of 10% between 2014 and 2018, from USD 0.22 per kWh to USD 0.14 (Woori Financial Research Institute, 2019).

- The wind power industry is also expected to grow in size, helped by the recent increase in government subsidies as well as massive offshore wind power projects set to get underway in the near future.
- A planned approach will be used to select sites for wind power complexes to more efficiently deal with problems related to resistance from the local community and avoid delays caused by the permit process. An upward adjustment will also be made to the values of REC weights to help improve the profitability of offshore wind projects.
- As of 2017, wind power manufacturing's share of total new and renewable energy manufacturing stood at 5.9% in the number of firms and 13.3% in the number of employees, with its shares in domestic sales, exports, and investment amounting to 6.1%, 11.7%, and 1.5%, respectively.
- Fuel cell sales have steadily increased since 2014, with exports growing at a particularly rapid pace.

* Sales (USD 1 million): (2014) 201 → (2015) 250 → (2016) 265 → (2017) 288

* Exports (USD 1 million): (2014) 0.18 → (2015) 61 → (2016) 66 → (2017) 90

New and Renewable Energy Industry (Manufacturing) Trends (Unit: USD 1 million, firm, person)

Year	Domestic sales (KRW 100 million)	Exports (KRW 100 million)	Sales investment (KRW 100 million)	Investment sales (KRW 100 million)	No. of firms	No. of employees
2014	3,980	2,849	769	8,759	438	15,545
2015	4,399	3,602	704	9,999	473	16,177
2016	3,868	3,577	608	8,921	405	14,412
2017	3,590	3,816	716	8,441	438	13,927

Source: "New and Renewable Energy Industry Statistics 2017" (KEMCO New and Renewable Energy Center, September 2018)

Note: Sales reported are on a shipment basis (domestic sales + exports + overseas factory shipments).

1.2 Industrial Competitiveness

New and renewable energy technology

- The Korea Institute of S&T Evaluation and Planning (KISTEP, 2018) estimates Korea's technological level in the new and renewable energy field to be at 86% (the highest level of technology being 100%), with a gap of about 10% to fill with advanced counterparts (Europe, US, Japan).
- Unlike Korea's technological prowess in terms of photovoltaic, hydrogen, and fuel cells, its wind power resources remain underdeveloped, with the gap between such technologies currently widening. Research and development are, therefore, urgently needed to improve technological competitiveness in this field.
- In addition to manufacturing, downstream industries of the new and renewable energy field, such as project development, finance, construction, and power plant operation and maintenance, have recently gained influence on job creation and sales.

New and Renewable Technology Competitiveness by Energy Source

Energy source	Annual government investment (USD 1 million) ¹⁾	Support toward meeting the supply target			Climate change response	Technological competitiveness		
		(2012–2035) Target average annual increase in energy production ²⁾	(2035) Target share by primary energy source ³⁾	(2018–2030) Target supply of new equipment and facilities ⁴⁾		Technological gap relative to world leaders ⁶⁾	Change in technological gap relative to world leaders ⁷⁾	Technological level relative to advanced countries ⁸⁾
Solar PV	5,098	○	○	◎	◎	◎	○	◎
Wind power	3,497	◎	○	○	◎	°	°	°
Hydrogen	598	-	-	-	◎	○	◎	○
Fuel cells	2,523	-	-	-	◎	◎	○	◎
Biomass	1,596	○	○	°	◎	○	°	○
Waste	882	°	◎	-	○	○	◎	○
Solar thermal	407	◎	°	-	°	◎	○	◎
Geo-thermal	553	◎	°	-	°	°	◎	○
Hydro-power	576	°	°	-	°	-	-	○
Marine	666	○	°	-	°	○	◎	°
Coal-based	239	-	-	-	°	°	○	○
Hydro-thermal	243	-	-	-	°	-	-	○

Source: "Core New and Renewable Energy Technology Evaluation Report" (KISTEP, July 2018)

1) 2013–2017, average annual investment by the government, "Project Budget Requirements" (2014–2018)

2) ◎: 15% or more, ○: 5% or more, °: 0% or more, "Fourth New and Renewable Energy Master Plan" (2014)

3) ◎: 20% or more, ○: 10% or more, °: less than 10%, "Fourth New and Renewable Energy Master Plan" (2014)

4) ◎: 30 GW or more, ○: 10 GW or more, °: 1 GW or more, "New and Renewable Energy 3020 Implementation Plan" (2017)

5) ◎: Investment priority group A, ○: Investment priority group B, °: Investment priority group C, "Clean Energy Technology Development Strategy" (2016)

6) ◎: 3 years or less, ○: 3–5 years, °: 5 years or more, "Technological Level Evaluation 2016" (KISTEP, 2017)

7) ◎: Reduced by 1 year or more compared to 2014, ○: Reduced by less than 1 year compared to 2014, °: Increased from 2014, "Technological Level Evaluation 2016" (KISTEP, 2017)

8) ◎: 80% or more, ○: 70% or more, °: 60% or more, "Report on New and Renewable Energy Technology in Korea and the Status of Foreign Technology Transfer" (KETEP, 2016)

Competitiveness of the photovoltaic industry

- With leading Korean module manufacturers (Hanwha Chemical, LG Electronics, etc.) listed by BNEF* as first-tier PV module manufacturers, Korea's technological level in PV manufacturing is among the best in the world.

* Cell efficiency: (Korea) 22%–23% ↔ (China) 20%–22%, module efficiency: (Korea) 20%–21% ↔ (China) 17%–19%

* Bloomberg New Energy Finance (BNEF) is an energy market research firm.

- According to BNEF's forecast, the market share of single-crystalline modules will exceed that of polycrystalline modules by 2020, which suggests that focusing on high-efficiency single-crystalline modules may be the best strategy for Korean manufacturers to improve their market position going forward.

- Although polycrystalline silicon solar cells currently account for a larger share of the market than single crystalline cells, 60.8% versus 32.2% as of 2017, an investment in the latter has been increasing at an accelerating rate.

- According to the industry statistics (2018) published by KEMCO in 2017, Korean investment in PV manufacturing amounted to USD 683 million, representing a 39.2% increase from the previous year, with the industry posting USD in 5.6 billion in sales and employing 7,522 workers.

- Although an export-oriented value chain exists in Korea, China currently leads the world market by virtue of the economy of scale as price competitiveness is paramount across the PV value chain.

* Korean investment (USD 1 million): (2014) 432 → (2015) 470 → (2016) 489 → (2017) 683

* Korean solar exports (USD 100 million): (2014) 24.2 → (2015) 30.0 → (2016) 29.0 → (2017) 32.5

Global Market Share by Solar Value Chain (2017)

Classification	Polysilicon (10,000 t)	Ingots-wafer (GW)	Cells (GW)	Modules (GW)	Installed capacity (GW)
World	43.2	106	104	105	99
China	24.2(56.0%)	87.6(83.0%)	72(69%)	75(72%)	53(54%)
Korea	4.9(11.3%)	1.2(1.1%)	5.2(5%)	7.7(7.3%)	1.4(1.4%)

Source: "Measures to Improve the Competitiveness of the Renewable Energy Industry" (Ministry of Trade, Industry and Energy, April 2019)

Note: Leading countries in installed solar PV capacity (2017): ① China (53.1 GW) ② US (10.7 GW) ③ India (9.1 GW) ④ Japan (7.5 GW) ⑤ Turkey (2.6 GW), ⑦ Korea (1.4 GW)

- PV companies outside China are focusing their resources on cutting the cost of production and improving the efficiency of their products, with governments in countries across the world exerting more efforts in protecting their firms and markets.

* (US) Cell and module safety guides issued (2018), (Turkey) Examining the option of imposing a domestic product quota for PV installations (2019) (Taiwan) Merger between solar PV companies (NSP+Gintech+Solartech → URE), with an investment from the government (about USD 160 million, 2018)

Competitiveness of the wind power industry

- The Korean wind power industry already has sufficient infrastructure in place. Hence, all it needs to grow is more investment and the development of a domestic market.
 - The industry has fully proven its domestic production and industrialization capabilities across all stages of the manufacturing value chain, from small parts to complete wind power generation systems, with growth evident in upstream industries, such as construction and engineering and O&M, in both quantitative and qualitative terms.
 - The manufacturing infrastructure currently in place is for onshore and offshore wind power generation systems of capacities ranging from 750 kW to 5 MW.
 - While there were nine wind turbine manufacturers in business during the boom period around 2010, there are currently four companies *specializing in the design and manufacture of onshore and offshore wind power generation systems.

* Doosan Heavy Industries (3 MW/5 MW-capacity systems), Hyosung Heavy Industries (5.5 MW-capacity), Unison (0.75–4.00 MW-capacity), Hanjin Ind. Co., Ltd. (2–4 MW-capacity).

- Testing infrastructure for products at all stage in the production process, from the demonstration of prototypes to the testing of actual-size blades and gearboxes
 - A demonstration and testing complex, built through government funding, and a world-class parts testing center are currently in operation.
 - Including the Wind Power Demonstration and Testing Complexes in Gimnyeong, Jeju and Yeonggwang, Jeonnam, and the Blade Testing Center for testing full-size blades, located in Buan, Jeonbuk.
- Several companies have world-class technologies for manufacturing wind power towers.
 - Thanks to the large pool of trained shipbuilding workforce (welding, etc.) and the well-developed steel industry infrastructure available in the country, Korean wind turbine manufacturers enjoy a significant advantage over others in terms of parts and materials supply. Moreover, operating production lines, both locally and abroad, own the infrastructure for the manufacture and exports of wind power generation systems of the

highest industry standard.

- The upstream industry comprises the likes of CS Wind supplying to leading global wind turbine manufacturers through its fully localized operations and other competitive firms that make the most of wind power-related production infrastructure available in Korea, such as Dongkuk S&C (Gyeongbuk) and Win&P (Gyeongnam).
- At present, Korea is globally competitive in forged wind turbine parts, such as shafts, bearings, and flanges, which are actively produced for exports.
 - Korean exports in wind turbine parts, produced by linking with steel parts manufacturing infrastructures, such as tower flanges, shafts, and bearings, are buoyant.
 - Parts makers, including Taewoong, Shilla Corporation, CS Bearing, and Hyunjin Materials, supply to leading global wind turbine manufacturers.

Competitiveness of the hydrogen industry

- Korean companies have advanced technologies in hydrogen-related fields, such as hydrogen vehicles and fuel cells.*
 - * Hyundai has developed NEXO, its hydrogen-powered vehicle with a range of 609 km between refueling, while POSCO has recently acquired core fuel cell energy (FCE) technology.
- Hydrogen is currently produced using extensive chemical industry infrastructure in places like Ulsan, Yeosu, and Daesan and is distributed through the LNG supply chain. Plans to promote the growth of related industries, such as hydrogen fueling stations, hydrogen vehicles, and fuel cells, are also underway.
 - In accordance with the recently unveiled Roadmap for the Promotion of the Hydrogen Economy (January 2019), an initiative is underway to expand the market for the hydrogen industry, which has particularly large upstream and downstream spillovers and could, for this reason, be a new engine of growth for the Korean economy.
 - The hydrogen industry contributes to the creation of new industrial ecosystems in metal processing, chemical, and machinery fields as it leads to the decarbonization of transportation (road, railway, and maritime transportation) fuels and the use of environmentally friendly fuel cell technology in DG systems, as well as giving rise to hydrogen production, transportation, storage, and refueling industries.

- Although countries like Japan, Australia, the United States and those in Europe are actively vying for leadership in this field, competition is still at an early stage. Moreover, global cooperation systems* between companies and countries are taking shape for different value chains of the hydrogen industry.

* In Australia, a project is being carried out to produce hydrogen from brown coal and export it to Japan in a liquefied form, to be used in the hydrogen industry.

- In Korea, amid the ongoing effort to build world-class technological capacity in hydrogen vehicles, fuel cells, and other hydrogen-related fields, the LNG supply chain is planned to be used in distributing hydrogen. Korean companies have significant experience both with the production of hydrogen, including byproduct hydrogen, and the construction of industrial infrastructure.
- A Hydrogen Economy Steering Committee has been formed to lead the effort in developing a hydrogen industry ecosystem and ensure the safe management of related products at all stages in the production process. Meanwhile, a special purpose corporation named the "Hydrogen Public-Private Partnership" is set to be launched, with legislative amendments also planned.

1.3

Promising Fields in Korea

Solar PV industry

- In keeping with changes in the global power generation industry, plans are drafted to strengthen Korea's technological capabilities in the solar PV and wind power fields, in tandem with policies to foster industrial growth and increase investment.
- The remarkable increase recorded in the installed capacity of solar PV in recent times is due to the drop in per-unit cost as a result of competitive price cuts by leading module manufacturers, as well as continuous efficiency improvement.
 - As the prices of PV modules fell 88% on average worldwide over the past nine years, their efficiency increased 55% during the same period.
 - * Per unit cost (USD/KRW): (2008) 3.82 → (2011) 1.30 → (2014) 0.64 → (2016) 0.47
 - * Efficiency (%): (2008) 10.7 → (2011) 11.7 → (2014) 15.9 → (2016) 16.6

- According to the Export-Import Bank of Korea (2019)¹⁾, as the global solar PV industry has now reached grid parity* and entered its second growth phase, companies that survive the supply competition are likely to control the value chain and heighten the entry barrier against late entrants.

* Grid parity: The point of equilibrium where the per-unit cost of power from a new or renewable energy source becomes equal to that of power from conventional fossil fuel sources.

- As a result, a second round of restructuring driven by per unit cost competition is expected to take place in earnest in the near future, especially among Asian companies in China, Taiwan, and Korea.
- In Korea, the domestic solar PV market has significantly grown in size, with companies proving their technological competitiveness in export markets worldwide, thanks, among others, to government initiatives such as the New and Renewable Energy 3020 Implementation Plan. However, as Korea lags behind China in terms of price competitiveness, the current focus is promoting the growth of the overall solar PV manufacturing industry.
 - More recently, an initiative has been launched to unify the overall control structure of the solar PV industry by reorganizing it around Hanwha Chemical, coupled with another initiatives to add new overseas plants in a bid to boost the industry's competitiveness.

Wind power industry

- US and European companies, the first in the world in the wind power industry, are also the current leaders of the global market. These companies have an edge in terms of price competitiveness thanks to their technological expertise allowing them to build and mass-produce large power generation systems with high usage rates.
 - In this field, where turbine manufacturing technology is the key competitiveness factor, Vestas (Denmark) remains the uncontested leader. In addition, Siemens (Germany) and GE (US) are currently seeking to expand their market dominance through M&A, while Chinese latecomers are exerting efforts to cut costs and narrow their technological gap.
 - * Leading countries in installed wind power capacity (2017): ① China (19.5 GW) ② US (7.0 GW) ③ Germany (6.6 GW) ④ UK (4.3 GW) ⑤ India (4.1 GW)
 - Market growth is expected to be driven by large capacity installations (10 MW or more) and offshore wind farms.

1) "Solar PV Industry Trends in Q4 2018, Paradigm Change in the World Power Generation Industry and Implications" (Export-Import Bank of Korea, February 2019)

- The Korean wind power industry is equipped with production infrastructure for key turbine components with high growth potential (blades, inverters, etc.).
 - Although currently, most parts companies have either reduced their production because of low domestic demand or have altogether ceased the production of wind power-related components, they have both the workforce and facilities to resume production immediately should there be new investment or demand.
 - The blade manufacturer Human Composites is capable of producing large 5 MW-capacity blades and the latest carbon fiber blades, while Plaspo is a developer and producer of inverters for large wind turbines.
- Given the current level of strategic support from the government, rapid growth is expected in upstream industries, including construction, installation, and O&M.
 - The construction of a wind power complex to help narrow the current gap in the technological and price competitiveness of Korean wind power generation systems is coupled with technology development projects to build core capabilities in O&M and other upstream industries across all stages in the production process.
 - Amid a growing demand for offshore wind power, the development, construction, installation, and O&M of offshore wind farms are expected to emerge as a key sector of the new and renewable energy industry as they tend to be large-scale projects demanding a high level of technological expertise.

Energy storage systems

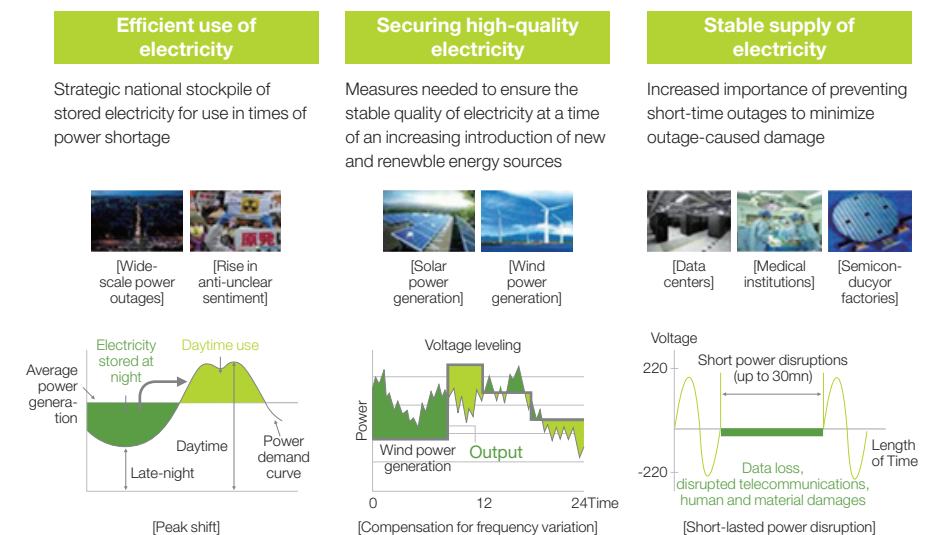
- With the increasingly widespread use of new and renewable sources of energy, there has also been progress in energy storage technology, allowing a better guarantee to the quality of electricity and the stability of the power grid system. Therefore, challenges of large-capacity storage and cost-related problems are likely to be resolved in the near future as well.
 - In 2017, the share of renewable sources in total energy supply increased sharply, putting a burden on the power grid system and also causing malfunctions or damage to receiving equipment because of irregular frequencies, which points to the need for a buffering system between producers and consumers.
- Energy storage systems store surplus energy in real time so that it can be used when needed. Depending on their efficiency and cost-effectiveness, they can be used in widely varied areas, including the management of power demand and emergency power supply.
 - A combination of various technologies is used in energy storage systems. In general, battery-based storage systems are preferred in the market over physical storage systems.

Lithium-ion secondary batteries are currently the leading technology because of their high efficiency and performance, as well as their excellent charge and discharge characteristics.

- According to BNEF (2019), with the gradual drop in the prices of lithium batteries, *the size of the global energy market is expected to grow from 5.4 GW in 2017 to 25 GW in 2020 to reach 940 GW over a long term by 2040.

* USD 1,160/kWh in 2010 → USD 577/kWh in 2014 → USD 176/kWh in 2018

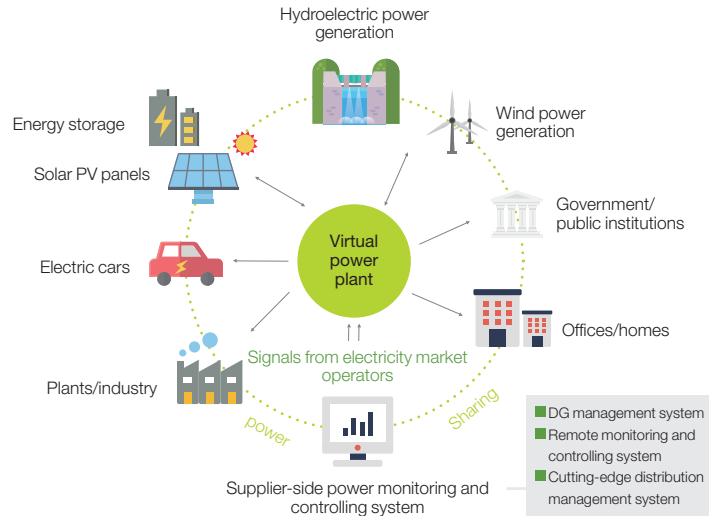
Role and Value of Energy Storage Systems



Source: "Paradigm Change in the World Power Generation Industry and Implications" (Export-Import Bank of Korea, January 2019)

- Virtual power plants (VPP) linking DG-type energy resources, such as small-scale power generation systems using new and renewable sources of energy and energy storage systems, that are operated through cloud-based software are expected to emerge.
 - As new and renewable energy sources have the disadvantage of the amount of power generation being irregular and variable, and power generation systems are scattered across a large geographic area, it is important to consolidate related resources for stable supply.
 - Thanks to progress in IoT technology, it is now possible to bundle DG systems, such as emergency generators, small-scale new and renewable energy power plants, and energy storage systems, to operate them like a single power plant.

Conceptual Diagram of a Virtual Power Plant
(requoted from the Korea Electrotechnology Research Institute)



Source: "Paradigm Change in the World Power Generation Industry and Implications" (Export-Import Bank of Korea, January 2019)

Hydrogen industry

- The recent announcement of the government's hydrogen economy roadmap has given new motivation to existing hydrogen fuel cell projects in which little progress has been made until now.
- A system was put in place to support the industry for all stages in the production cycle, from the production of hydrogen to its storage, transportation, and use, to turn hydrogen into a new engine of economic growth and use it as an environmentally friendly source of energy.
 - Massive investment from the government is expected to develop an ecosystem for the hydrogen industry, which is needed to create an infrastructure industry, including production, storage, and transportation, and to build necessary physical and legal infrastructure.
 - Measures have been undertaken to encourage private sector investment in hydrogen vehicles, fuel cells, and other core technologies, along with those measures to enable the mass commercial production of hydrogen (by 2022) and develop a large demand and supply system (by 2030) needed for the creation of hydrogen markets locally and abroad.

02 Foreign Direct Investment Trends



2.1

Foreign Direct Investment Status

Overall trends of foreign direct investments in Korea

- According to the Korea Development Bank (2019),²⁾ the inflow of foreign direct investment (FDI) in Korea has steadily increased since 2013 to rise to a historic high of USD 26.9 billion in 2018, on a reported basis.

- This represents an 86% increase from 2013 (USD 14.5 billion) and a 17% increase from 2017 (USD 23.0 billion).

- The average value of FDI per project is also on an upward trend, with a growing number of projects worth USD 100 billion or more.

- Recently, there has been a noticeable increase in FDI in manufacturing, driven by the rising investment for participation in the Fourth Industrial Revolution-related global value chain (GVC).*

* Refers to the global division of labor in which different countries participate at different stages of the product cycle, from design and supply of parts to production, distribution, and sales. In the case of Korea, it produces intermediate goods, such as machinery and semiconductors, which are needed for the manufacture of parts.

- Recently, there has been a surge in Chinese investment in Korea, while the steady inflow of FDI continues from key investors like the United States and Europe.

* (2017 → 2018, USD 1 million) Overall 22,948 → 26,900, China 809 → 2,743, US 4,710 → 5,879, EU 7,030 → 8,921

FDI trends in new and renewable energy-related KSIC industries (subclasses)

- While the new and renewable energy industry is classified according to the source of energy into fuel/equipment manufacturing, construction, power generation, and services, these categories are absent in traditional industrial classification systems, making it difficult to assess the status of FDI in this field.

- When estimated using the special classification by KEMCO (2019), FDI in the new and

2) "Key Characteristics of FDI in Korea" (Korea Development Bank, February 2019).

renewable energy industry appears to have increased at an average annual rate of 37.8% over the past three years.

- Amid an increase in the share of basic chemicals needed in the solar power value chain in total manufacturing, there has been a sharp surge in the joint venture and equity investment in power generation.

Investment in the New and Renewable Energy Industry by Foreign Companies

(Unit: number of projects, USD 1,000)

KSIC	2016		2017		2018	
	No. of reported projects	Reported value	No. of reported projects	Reported value	No. of reported projects	Reported value
Manufacture of basic chemicals	20	374,813	16	263,301	14	566,304
Manufacture of synthetic rubber and plastics	12	113,157	11	105,766	20	13,243
Manufacture of other chemical products	39	653,182	48	1,375,549	68	1,119,672
Manufacture of primary nonferrous metals	9	161,180	10	333,358	12	187,812
Manufacture of structural metal products, tanks, reservoirs, and steam generators	6	20,635	11	16,521	3	2,335
Manufacture of other fabricated and processed metal products	14	12,057	20	171,562	15	89,820
Manufacture of general-purpose machinery	28	67,232	32	143,507	42	412,711
Manufacture of special-purpose machinery	35	359,494	39	302,672	29	284,758
Manufacture of medical devices	21	28,351	19	47,443	13	94,581
Manufacture of primary cells, batteries, and accumulators	10	88,873	15	304,413	9	256,144
Manufacture of electric motors, power generators, and devices for power conversion, supply, and control	11	143,496	20	82,609	16	197,130
Manufacture of other electrical equipment	13	60,326	13	38,877	9	23,285
Manufacture of semiconductors	19	232,437	10	89,494	21	711,366

KSIC	2016		2017		2018	
	No. of reported projects	Reported value	No. of reported projects	Reported value	No. of reported projects	Reported value
Manufacture of magnetic and optical media	1	4,746	0	0	0	0
Other manufacturing	6	29,877	8	40,976	15	85,835
Repair services of industrial machinery and equipment	4	6,262	1	657	4	51,537
Electric power generation	4	298,161	6	135,279	25	1,000,615
Waste treatment services	2	50,087	2	98,110	3	23,755
Civil engineering and construction	11	100,586	5	6,330	6	209,074
Installation of building equipment	2	1,492	0	0	3	328
Electrical and communication works	1	2,469	2	221	1	191
Total	268	2,808,913	288	3,556,645	328	5,330,496

Source: "Trade, Industry and Energy Ministry Statistics of Foreigners' Investment in Korea" (Ministry of Trade, Industry and Energy, August 2019).

Note: Because of the absence of official classification related to new and renewable energy industries, FDI in this field was estimated using the subclasses of the Korean Standard Industrial Classification (KEMCO, 2019).

- New projects to establish local corporations in Korea by Japanese, German, Spanish, and Chinese investors to make inroads into the Korean solar and wind power markets are recently underway. The permit process and issues related to the resistance of local communities will be dealt with through the help of their Korean partner firms, with their partnership likely to take the form of equity participation.

- A continuous stream of leading European and North American companies setting up their Korean corporations is existing to participate in offshore wind farm projects through their subsidiaries, local governments, or Korean partner companies.

Companies Set Up by Foreign Investors in the Past Five Years (as of August 2019)

Year incorporated	Country	Company name	Type of business
2019	Denmark	Ørsted Korea Limited	Renewable energy power generation
	Japan	Influx Korea	Solar power generation consulting
	Hong Kong	Korea Cloud Energy Limited	Solar and wind power generation
	Spain	FRV Services Korea Limited	Solar power generation
	Australia	Bamboo	Trade and solar power generation
	Thailand	B.Grimm Power (Korea) Limited	Wind power and other new and renewable power generation, and other activities incidental and linked thereto
	UK	Korea Solar Energy Holding	New and renewable energy business
	Hong Kong	Ryzen Korea	Investment in, and sales of, solar power generation systems
	China	Synergy Korea Works	Wholesale and retail distribution of solar thermal power generation-related parts and technology consulting
	Japan	Lucun	Renewable energy investment, business consulting, real estate sales, IT, M&A, etc.
	Sweden	CoensHexicon	Wind power-related engineering services, development and consulting
2018	Japan	JS Power	Solar and wind power
	Denmark	Copenhagen Offshore Partners Korea	Development of wind power plants, related consulting, and management services
	Germany	wpd Korea	Development of renewable energy (wind and solar PV) businesses
	UK	Canadian Solar Project	Solar power generation
	Thailand	Rena International Corp.	Module manufacturing, new and renewable energy design, new and renewable energy-related parts sales, electrical work, etc.
	Singapore	GCL System Integration Technology Korea	Imports and exports, and the processing of solar power equipment and components, purchase, sales, and imports and exports of power and energy systems
	Japan	Bellison Power	Construction and operation of wind power plants
	China	TPS	Manufacture of general steel doors and cast components of solar power systems
	Japan	I-Luck Korea	Planning and development, manufacturing, O&M, consulting, and investment consulting in new and renewable energy
	Japan	House Techno	Solar power generation consulting
	Japan	Pregrip Korea	Solar power generation consulting
	Canada	KBR Solar Development Corp.	Solar power generation
	US	Pacifico Energy Korea	Solar power consulting
	Japan	GTK Solar	Solar power generation
	China	Grandsun	Solar power generation equipment manufacturing

Year incorporated	Country	Company name	Type of business
2017	China	BG Industries	Manufacture of solar power generation systems
	UAE	ST Energy	New and renewable energy business (technology service and solar panel and equipment manufacture)
	US	NGP	Manufacture of solar chargers
	Norway	Nel-Duckyang	Development, sales, installation, and operation of hydrogen refueling stations and the development of related technologies
	Japan	DI Power	Investment in the supply of solar power generation system-related products
	Hong Kong	Stin Korea	New and renewable energy business, electrical work
	US	T&Tech	Development of software and solar power generation monitoring systems
	China	CG Solar	Manufacture of solar PV modules
	US	Suntree Energy	Solar power generation
2016	Japan	SPIP	Design, installation, maintenance, and repair of solar power generation systems, real estate investment, business and financial consulting, etc.
	Hong Kong	JA Solar Korea	Manufacture of solar PV components
2015	US	TSIFG	New and renewable energy development projects, technology consulting, and contract research services
	Singapore	Rheem Korea	Installation of new and renewable energy systems and equipment
	Denmark	Deif Korea	Energy control solutions, wind turbine control solutions, ship engine control system manufacture, and sales
	Japan	Mabuchi Engineering Korea	New and renewable energy-related manufacturing
	Hong Kong	Goldwind International Korea	Manufacture and sales of wind turbines
	UK	Romax Insight Korea	Renewable energy development, consulting
	Japan	Just Save	Consulting services on sales, management, rental of real estate, solar PV and wind power business, and other activities incidental thereto
	Japan	MGK Korea	Installation of solar power systems
	Germany	Merica Korea	Renewable energy, forestry business
	Cayman Islands	Hanwha Q Cells	Development, manufacture, and sales of solar cells (including modules) and solar power generation systems, and other businesses incidental thereto

Source: "Foreign-Invested Company Information" (Ministry of Trade, Industry and Energy, August 2019)

2.2

Success Cases of Major Foreign-Invested Companies

Marine offshore wind power projects

- Busan Metropolitan City is conducting a wind power project as one of the core projects toward reaching its new and renewable energy autonomy target of 30%.
 - The construction of an offshore wind power complex with a total capacity of 540 MW is planned, including eight 5 MW generators off Cheongsapo and one hundred 5 MW units 1.2 km offshore in locations between Jukseong, Gijang-eup, and Imnang, Jangan-eup, in Gijang-gun.
 - In 2015, G Wind Sky, a wind power firm established in 2013, signed an MOU with the British investment company Castlepines Global Equities on a USD 194 million worth of investment after the completion of a feasibility review by the Korea Institute of Energy Research (KIER) and an accounting firm.
 - The sea off Busan unites ideal conditions, with an annual average wind speed per second of about 7 m and favorable seafloor topography. Moreover, the moderate depth of 30 m makes it easy to install needed structures while also allowing the power transmission circuit of the Gori Nuclear Power Plant to be used unmodified. As such, the presence of large electricity markets in Busan and nearby Ulsan is another great advantage offered by this site.

Floating offshore wind power complex project in Ulsan

- The City of Ulsan has announced a plan to convert the Donghae-1 gas field, which will stop production in 2021, into an offshore substation and wind power complex.*
 - * A USD 5.4 billion project for a 200 MW-capacity (40 × 5 MW units) wind power complex, deployed across five sites
 - During a private investor conference held in 2017, four global investment companies, including SK E&S-CIP (Danish investment firm), GIG (British investment firm), CoensHexicon (joint venture between Hexicon AB, a Swedish engineering house specialized in floating multi-turbine platforms, and Coens, an offshore oil and gas platform company), and Wind Power Korea (WPK) indicated their desire to participate in the project.
 - Discussions are also underway with Germany's EON, the multinational investment company Macquarie Capital, and Equinor, Norway's state-owned oil and electricity company, about their potential participation.

- Macquarie Capital signed an MOU with Gyeongbuk Floating Offshore Wind Power on an investment in a 1 GW system (May 2018).

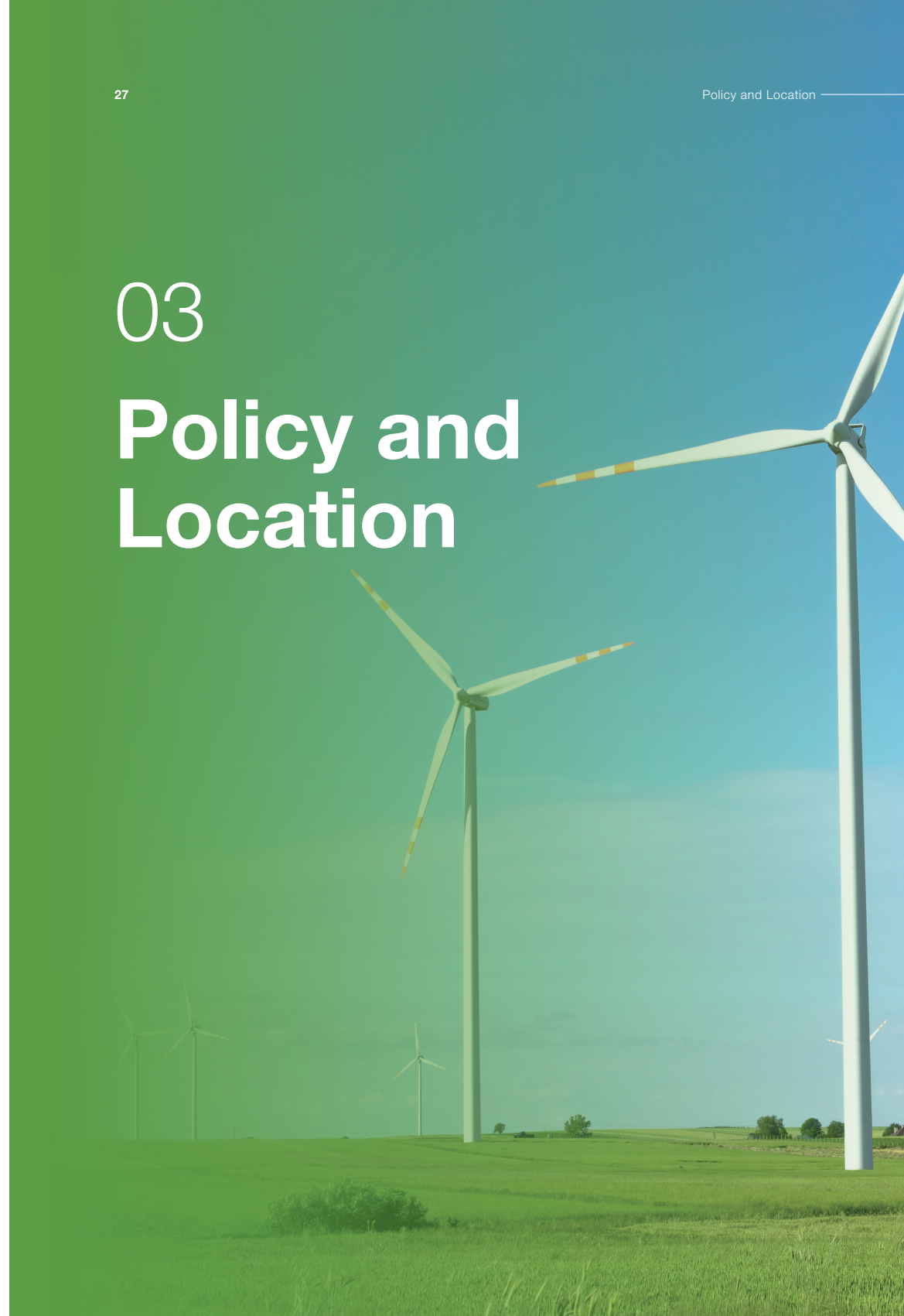
Solar PV project in Yeosu

- Yeosu City signed the “New and Renewable Energy Business MOU” on USD 363 million worth of investment with Japan’s Techno System Co., Ltd. (February 2018).
- The project will install landscape lighting systems in carefully selected sites that are suitable for solar power generation, such as water retention sites, riverside lots, and unused land, and construct a new and renewable energy exhibition and information center.

Saemangeum renewable energy cluster

- The construction of a Rena International plant began within the Saemangeum Industrial Complex (June 2019), for which Japan’s Influx Inc. contributed USD 1 billion, and China’s JA Solar an in-kind contribution of USD 300 million.
- The plant constructed under this project with a total investment of USD 5 billion will produce, upon its completion, solar PV modules, mounting structures, and energy storage systems for both domestic supply and exports.
- This plant, which is set to hire 120 employees, is expected to create new jobs in the Jeonbuk area and provide a welcome jolt to the local economy.
- In Gunsan, where an area is recently designated as an “industrial crisis area,” a corporate tax exemption is offered to business startups and new plants or other business establishments of an existing company for the first five years.

03 Policy and Location



3.1

Key Policies and Incentives

Fourth New and Renewable Energy Master Plan (September 2014)

- A deployment plan for the period leading up to 2035 has been drawn up in accordance with the Fourth New and Renewable Energy Master Plan.
- The plan for 2014–2035 sets the target share of new and renewable energy sources in total installed capacity to 11% (13.4% relative to total power generation), with the demand for primary energy expected to increase at an average annual rate of 0.7%, and that for new and renewable energy at an average annual rate of 6.2% over the same period.

Share Target by Primary Energy Source

(Unit: %)

Classification	2012	2014	2025	2035	Average annual rate of increase
Solar thermal	0.3	0.5	3.7	7.9	21.2
Solar PV	2.7	4.9	12.9	14.1	11.7
Wind power	2.2	2.6	15.6	18.2	16.5
Biomass	15.2	13.3	19.0	18.0	7.7
Hydropower	9.3	9.7	4.1	2.9	0.3
Geothermal	0.7	0.9	4.4	8.5	18.0
Marine energy	1.1	1.1	1.6	1.3	6.7
Waste-to-energy	68.4	67.0	38.8	29.2	2.0

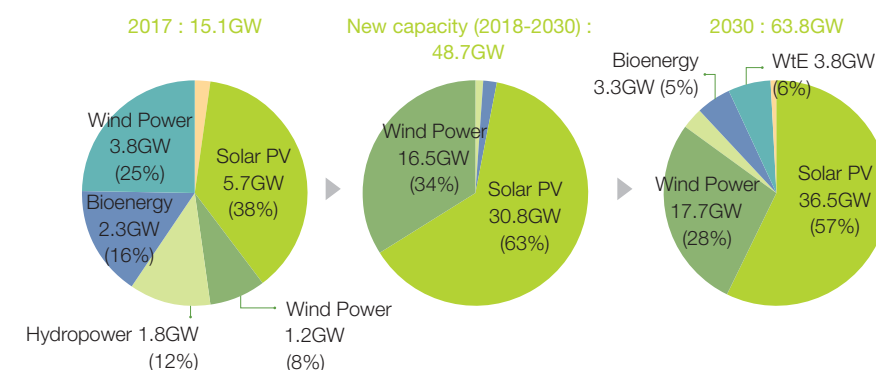
Source: "Fourth New and Renewable Energy Master Plan" (Ministry of Trade, Industry and Energy, September 2014)

- Six Implementation Strategies: ① A consumer participation-based revenue model and demand-tailored supply ② Design and operation of a market-friendly renewable portfolio standard (RPS) ③ Region and source-specific supply strategies to develop various different business models ④ Expansion of new and renewable energy markets, including the hot wastewater reuse and transportation and heat markets, etc. ⑤ Strengthening R&D capabilities in new and renewable energy technology ⑥ Building international standard certification infrastructure for new and renewable energy and the improvement of the regulatory framework

New and Renewal Energy 3020 Implementation Plan (December 2017)

- This plan established by the Moon Jae-in administration has set the goal of progressively raising the share of new and renewable energy relative to total power generation to 20% by 2030.
- Clean energy sources, such as solar and wind power, to account for over 95% of new energy installations.

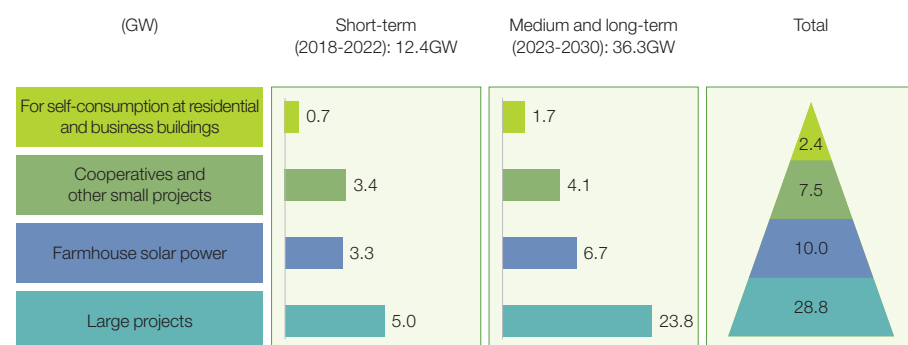
Capacity Targets under the New and Renewable Energy 3020 Implementation Plan by Energy Source



Source: "New and Renewable Energy 3020 Implementation Plan" (Ministry of Trade, Industry and Energy, December 2017)

- With the short-term (2018–2022) target set to 12.4 GW and the medium and long-term (2023–2030) target to 36.3 GW, the plan is to supply solar and wind power and other types of clean energy, incite the participation of local communities and the general public, and undertake large-scale planned development projects.
- The target is to be reached through citizen-participated power generation projects, such as installations for self-consumption (2.4 GW), cooperatives and other small-scale projects (7.5 GW), farmhouse solar projects (10 GW), and other large-scale projects (28.8 GW).

Capacity Targets and Key Projects under the New and Renewable Energy 3020 Implementation Plan by Sector



Key projects	Planned activities	Expected benefits
Expanding citizen-participated power generation projects	Expanded supply of urban and rural solar power, introducing a Korean-style feed-in tariff	Creation of an environment for citizens to participate in the market
A power generation site planning system introduced to local governments	Selection of candidate sites and calling for tenders	Increased acceptance from local residents, preclusion of adverse environmental impacts
Large-scale power development projects	Discovering and launching large-scale projects by public institutions, power generation companies and local governments, etc.	Development of large-scale solar PV and wind power generation complexes
Improvement of new and renewable energy supply conditions	Easing zoning restrictions, strengthening the capabilities of local administrations	Increased revenue for power generation businesses
Expanded supply of environmentally friendly renewable energy	Exclusion of nonrenewable waste, improvement of the power generation permit process	Environmental impact minimized

Source: "New and Renewable Energy 3020 Implementation Plan" (Ministry of Trade, Industry and Energy, December 2017)

Measures to Improve the Competitiveness of the New and Renewable Industry (April 2019)

• Measures to support the New and Renewable Energy 3020 Implementation Plan and create new engines for growth by strengthening solar and wind power industry ecosystems

- With the stated vision of "developing the renewable energy industry into a new engine to drive future economic growth above and beyond its role as the provider of environmentally friendly energy sources," the goal is to "make Korea into a renewable energy technology powerhouse by creating an advanced industrial ecosystem."
- The measures include introducing a carbon certification system, restructuring the Renewable Energy Certificate (REC) trading market, reusing spent modules, introducing a minimum energy performance standard (MEPS), and strengthening after-sales management, all aimed at shifting market competition to competition based on product efficiency and quality.
- Meanwhile, the proposed measures also include those to boost the competitiveness of the industrial ecosystem, such as promoting the growth of the domestic market, repowering and participating in RE100, a private sector-led R&D roadmap, and developing regional innovation ecosystems (Jeonbuk, Jeonnam, East Sea, Gyeongnam, and Chungcheong zones).
- On the list are also measures, such as stepping up export support for strategic regional markets, export finance at preferential terms, and group initiatives for overseas expansion.

Support programs for the new and renewable energy industry

• To expand investment in new and renewable energy, support will be provided using REC weights assigned to respective energy sources as a policy tool.

- While support for solar PV, wind power, hydrogen fuel cells, and energy storage systems has been massively increased, support for biomass and waste has been sharply cut.
- A certain percentage** of investment by Korean persons* in energy-saving facilities (including new and renewable energy facilities) is now tax-deductible pursuant to Article 25 of the Restriction of Special Taxation Act (until the end of 2021).

* Residents pursuant to the Income Tax Act and domestic corporations pursuant to the Corporate Tax Act

** 7% for SMEs, 3% for mid-sized firms, and 1% for others

Weight under the Renewable Portfolio Standard by Energy Source

Energy source	Current	After revision	Adjustment and background
Offshore wind	1.5–2.0	2.0–3.5 (per distance interval)	Upward adjustment
Hydrogen fuel cells	2.0	2.0	Higher weight applied
Energy storage systems (ESS)	Solar-linked 5.0 Wind power-linked 4.5	4.0 (from 2020)	Highest weight applied
Woodland solar (unchanged for existing solar systems)	0.7–1.2	0.7	To bar the entry of speculative investors
Biomass (wood pellets, discarded wood)	1.0	0.5	No weight applied
Nonrenewable waste	1.0	-	Not recognized as a new or renewable energy source

Source: KEMCO New and Renewable Energy Center (June 2018)

- The Ministry of Trade, Industry and Energy (2019) provides support for investment attraction through cash support and the deferred application of industry convergence and ICT convergence regulations (sandbox), aimed at assisting with the global value chain upgrade of industrial structure.

- By taking a comprehensive account of future trends and directions of the industrial policy, the focus is placed on industrial technology R&D* and related fields, with various incentives including the Fund for the Promotion of Foreigners' Investment in New Industries** and the online investment matching system *** currently being offered.

* Self-driving cars, smart home, energy efficiency improvement, hydrogen energy, new and renewable energy, etc.

** A fund investing in competitive Korean SMEs to build international investors' confidence in them and thereby promote foreign investment in (USD 45 million)

*** A platform for matching Korean firms in need of foreign investment with foreign companies interested in investing in Korean firms (OASIS)

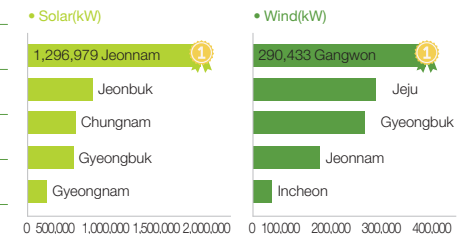
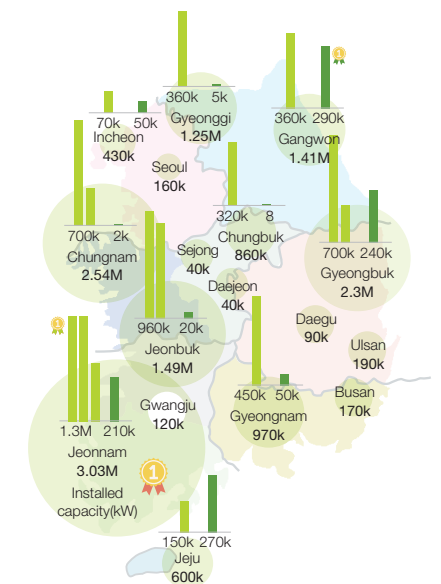
3.2 Major Locations

New and renewable energy supply status by geographic area

- In 2017, the cumulative installed capacity of new and renewable energy was the largest in Jeonnam (19.3%), followed by Chungnam (16.2%) and Gyeongbuk (14.7%), with Jeonnam (22.2%) also ranking the highest in the installed capacity of solar PV, followed by Jeonbuk (16.4%) and Chungnam (12.1%).

Cumulative Installed Capacity (MW) of New and Renewable Energy and Solar PV

Classification	New and renewable	Solar	Wind [kW]
Overall	15,703	5,835	1,143,359
Seoul	164	84	101
Busan	174	89	804
Daegu	94	63	13
Incheon	429	74	49,095
Gwangju	117	112	1
Daejeon	37	37	200
Ulsan	190	39	1,657
Sejong	44	34	
Gyeonggi	1,247	361	5,276
Gangwon	1,413	361	290,433
Chungbuk	860	317	8
Chungnam	2,537	705	2,043
Jeonbuk	1,494	957	22,818
Jeonnam	3,029	1,297	207,719
Gyeongbuk	2,302	703	241,641
Gyeongnam	969	454	48,575
Jeju	603	148	272,976



Source: "New and Renewable Energy Supply Statistics 2017" (KEMCO, November 2018)

New and renewable energy supply potential

- By geographical area, the solar PV market potential is the highest in Gyeongbuk (20.4%), followed by Chungnam (15.4%) and Gyeonggi (12.2%).

Solar PV and Wind Power Supply Potential (GW) by Geographical Area

Classification	Definition
Theoretical	Potential amount of energy that could be produced if the total solar energy (solar radiation quantity) radiated to the surface of the earth (territory) is used.
Technical	Potential amount of energy that could be produced by considering technical limitations such as equipment efficiency and excluding areas inadapted for energy production because of geographical constraints.
Market	Potential amount of energy that is economically feasible to produce when government support and regulations are taken into account.

Classification	Solar PV			Onshore wind power			Offshore wind power		
	Theoretical	Technical	Market	Theoretical	Technical	Market	Theoretical	Technical	Market
Overall	106,830.6	1,807.2	321.0	498.8	352.3	16.7	461.6	386.6	22.0
Seoul	648.1	20.2	0.7	3.0	2.6	-	-	-	-
Busan	825.1	19.1	1.5	3.9	2.6	0.0	10.8	10.2	0.8
Daegu	941.2	18.5	3.5	4.4	3.0	0.0	-	-	-
Incheon	1,128.3	37.0	3.2	5.3	4.4	0.1	74.8	69.1	0.4
Gwangju	532.6	15.5	3.6	2.5	2.0	0.0	-	-	-
Daejeon	578.6	11.5	1.2	2.7	2.1	-	-	-	-
Ulsan	1,125.8	18.4	2.4	5.3	3.8	0.1	5.0	4.8	0.1
Sejong	498.4	11.3	2.0	2.3	2.0	-	-	-	-
Gyeonggi	10,878.5	233.8	39.2	50.9	41.2	0.1	-	-	-
Gangwon	17,777.8	131.3	23.2	83.1	48.2	1.1	24.6	10.1	0.0
Chungbuk	7,927.5	118.1	29.2	37.1	25.1	0.5	-	-	-
Chungnam	8,779.2	214.3	49.4	41.0	33.2	2.1	44.6	41.3	3.6
Jeonbuk	8,638.0	184.9	29.1	40.4	28.9	0.5	21.8	20.1	0.0

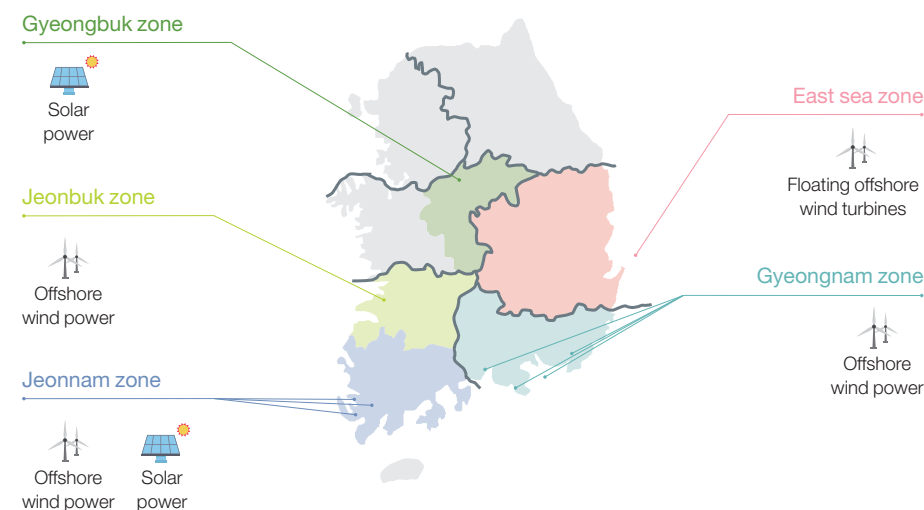
Classification	Solar PV			Onshore wind power			Offshore wind power		
	Theoretical	Technical	Market	Theoretical	Technical	Market	Theoretical	Technical	Market
Jeonnam	13,006.8	276.7	22.0	60.1	42.5	2.9	141.5	125.0	9.9
Gyeongbuk	20,335.9	264.8	65.6	95.1	68.8	6.3	45.5	18.7	0.2
Gyeongnam	11,232.7	171.7	29.5	52.5	32.9	1.1	36.9	32.3	5.8
Jeju	1,976.1	60.1	15.7	9.2	9.0	1.9	56.1	55.0	1.2

Source: "Results of a New and Renewable Energy Resource Potential Study" (Korea Energy Economics Institute & Korea Institute of Energy Research, 2017)

Developing renewable energy innovation ecosystems across the country

- A plan is underway to build innovation infrastructure in areas with existing renewable energy industry infrastructure or slated for a large-scale renewable energy project to create industrial ecosystems that are adapted to each area and develop them into new hubs of innovation.

* (Local governments) Taking the initiative in discovering and carrying out large-scale projects suitable for their respective areas (National government) Developing infrastructure, including research facilities, and providing support for R&D, demonstration, and workforce training



Region	Current Status and Future Direction
Chungbuk zone	<ul style="list-style-type: none"> • (Current status) Home to a large number of solar PV manufacturers, providing 67% of the total domestic production of cells and modules <ul style="list-style-type: none"> - Projects are currently underway for 1 GW in total capacity in this area that is well equipped with solar power manufacturing infrastructure. • (Future direction) A specialized area for the development and demonstration of solar PV products and other new hybrids, convergence-based products and services
Gyeongnam zone	<ul style="list-style-type: none"> • (Current status) Home to 84 companies manufacturing wind turbines (Doosan Heavy Industries, Unison) and wind turbine parts <ul style="list-style-type: none"> - Offshore wind power projects for 1.9 GW in total capacity underway including in Yokjido Island • (Future direction) A mega hub for the development, demonstration, and production of wind power system parts
East Sea zone	<ul style="list-style-type: none"> • (Current status) An area with a dense cluster of 750 shipbuilding, maritime, and heavy-industry companies and a favorable wind direction (8–8.5 m/s) <ul style="list-style-type: none"> - A project is underway to create a 1 GW-capacity floating wind power complex near the Donghae-1 gas field • (Future direction) Development and timely industrialization of wind power systems, including R&D, demonstration, and commercialization of floating offshore wind turbines
Jeonbuk zone	<ul style="list-style-type: none"> • (Current status) Saemangeum slated for a renewable energy cluster project <ul style="list-style-type: none"> - A project with residents' participation to build solar PV (3 GW) and wind power (1 GW) systems. • (Future direction) A manufacturing, construction, and research cluster whose members will include some of the shipbuilding equipment and materials companies converted into energy equipment manufacturers
Jeonnam zone	<ul style="list-style-type: none"> • (Current status) The nation's largest producer of solar PV equipment, accounting for a 22% share (1.3 GW) <ul style="list-style-type: none"> - New solar PV (2 GW, Lake Yeongam, etc.) and wind power (0.8 GW, Wando Island, etc.) projects are underway. • (Future direction) A hub of convergence-type businesses for piloting regional win-win models

Source: "Measures to Improve the Competitiveness of the Renewable Energy Industry" (Ministry of Trade, Industry and Energy, April 2019)

04 Potential Partners



4.1

List of Related Companies

Classification	Company name	Key products	Website URL	Location
Solar PV	Hanwha Q Cells	Modules, EPC	www.hanwha-qcells.com	Seoul, Chungbuk
	LG Electronics	Modules, consulting	www.lge.co.kr/kr/business	Seoul, Gyeongbuk
	OCI	Polysilicon	www.oci.co.kr	Seoul, Jeonbuk
	OCI Specialty	SlimRod, wafers	www.ocis.co.kr	Chungnam
	Hyundai Energy Solutions	Modules, inverters, EPC, O&M	www.hyundai-es.co.kr	Seoul, Chungbuk
	S-Energy	Modules, EPC	www.s-energy.com	Seoul, Jeonbuk
	Hansol Technics	Modules, inverters	hansolsolar.com	Gyeonggi, Daejeon
	Hanwha Chemical	Polysilicon	hcc.hanwha.co.kr	Seoul, Chungbuk
	Shinsung E&G	Cells, modules, consulting, construction and engineering, O&M	www.shinsungeng.com	Seoul, Jeonnam
	Hyundai Energy Solutions	Construction and engineering	www.hyundai-energy.co.kr	Gyeonggi, Chungbuk
	Topsolar	Construction and engineering	topsolar.kr	Seoul, Gyeongbuk
	Nelectric	Construction and engineering	www.nelec.co.kr	Jeonbuk
	Topinfra	Construction and engineering, consulting, O&M	topinfra.co.kr	Jeonnam, Gwangju
	OCI Power	Inverters, EPC, consulting, O&M	solar.oci.co.kr	Seoul, Jeonbuk
	Wonik IPS	Reactive Ion Etching (RIE)	www.ips.co.kr	Gwangju
	SKC	Polyester films, PVdF films, EVA/POE foam sheets, backsheets	www.skc.kr	Gyeonggi, Daejeon
	Dasstech	Inverters, monitoring systems	www.dasstech.com	Seoul, Jeonnam
	SFC	Backsheets	sfcltd.co.kr	Seoul, Jeonbuk
	Astronergy Solar Korea	Modules, inverters, construction and engineering, O&M	www.astronergy.co.kr	Gyeonggi
	S-Power	O&M	s-power.com	Seoul, Incheon

Classification	Company name	Key products	Website URL	Location
Solar PV	Topsun	Modules, construction and engineering, consulting, O&M	www.topsun.kr	Gyeonggi
	Willings	Inverters, construction, and engineering	www.willings.co.kr	Seoul, Gyeonggi
Wind power	CS Wind	Towers	www.cswind.com	Chungnam
	Taewoong	Main shafts, tower flanges, bearings, etc.	www.taewoong.com	Busan
	Dongkuk S&C	Towers, EPC, O&M	www.dongkuksnc.co.kr	Gyeongbuk
	Unison	Power generation systems, towers, EPC, O&M	www.unison.co.kr	Seoul, Gyeongnam
	Hyunjin Materials	Main shafts	www.hjmco.co.kr	Busan
	Shilla Corporation	Slewing ring bearings	www.shillacorp.co.kr	Chungnam
	Doosan Heavy Industries	Power generation systems, EPC, O&M	www.doosanheavy.com	Gyeongnam
	CS Bearing	Bearings	www.samhyun-eng.com	Gyeongnam
	Seohan ENP	Main shafts, flanges, bearings, gear rims, etc.	www.seohanenp.com	Gyeongbuk
	Speco Wind Power	Towers	kr.speco.co.kr	Chungbuk, Mexico
	Anyteksys	Power generation systems (small size)	http://www.anytek.com/	Seoul
	JAC Coupling	Couplings	www.jacoup.co.kr	Busan
	Human Composites	Blades	www.humancomposites.com	Jeonbuk
	Hyosung Heavy Industries	Power generation systems	www.hyosungheavyindustries.com	Gyeongnam
Fuel cells	Doosan Fuel Cell	Fuel cell power generation systems, stacks, fuel reformers, MEA (Membrane Electrode Assembly)	www.doosanfuelsell.com	Chungbuk
	POSCO Energy	Fuel cell power generation systems	www.poscoenergy.com	Chungnam
	S-Fuelcell	Fuel cell power generation systems	www.s-fuelcell.com	Seoul
	CNL Energy	Fuel cell power generation systems	www.cnl.co.kr	Gyeonggi
	G-Philos	Fuel cell inverters	g-philos.co.kr	Jeonnam
	Dongjin Semichem	Membrane electrode assembly (MEA)	www.dongjin.com	Gyeonggi

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Related Associations

Name	Website URL	Activities
KEMCO New and Renewable Energy Center	www.knrec.or.kr/ knrec/index.asp	An organization providing professional and efficient support for the development, supply, and industrialization of new and renewable energy
Korea New and Renewable Energy Association	www.knrea.or.kr	An industry association defending the common interest of the new and renewable energy industry and promoting shared growth
Korea Photovoltaic Industry Association	www.kopia.asia	An industry association defending the common interest of the solar PV industry and promoting shared growth
Korea Wind Energy Industry Association	www.kweia.or.kr	An industry association defending the common interest of the wind power industry and promoting shared growth
Korea Geothermal Energy Association	www.kogea.or.kr	An industry association defending the common interest of the geothermal industry and promoting shared growth
Korea Bioenergy Association	www.kbea.or.kr	An industry association defending the common interest of the bioenergy industry and promoting shared growth
Forest Biomass Energy Association	www. biomassenergy.kr	An industry association defending the common interest of the forest biomass industry and promoting shared growth
Korea Waste Association	www.kwste.or.kr	An industry association defending the common interest of the waste industry and promoting shared growth
Korea Lubricating Oil Industries Association	www.kloia.or.kr	An industry association defending the common interest of the lubricating oil industry and promoting shared growth
Korea Incineration plant	www.k-inc.co.kr	An industry association defending the common interest of the household waste industry and promoting shared growth

Name	Website URL	Activities
Korea Hydrogen Industry Association	www.h2.or.kr	An industry association defending the common interest of the hydrogen and fuel cell industry waste and promoting shared growth
Korea Energy Technology Evaluation and Planning	www.ketep.re.kr	An energy policy research institute conducting research in areas including new and renewable energy
Korea Institute of Energy Research	www.kier.re.kr	An energy policy research institute conducting research in areas including new and renewable energy
Korea Energy Economics Institute	www.keei.re.kr	An energy policy research institute conducting research in areas including new and renewable energy

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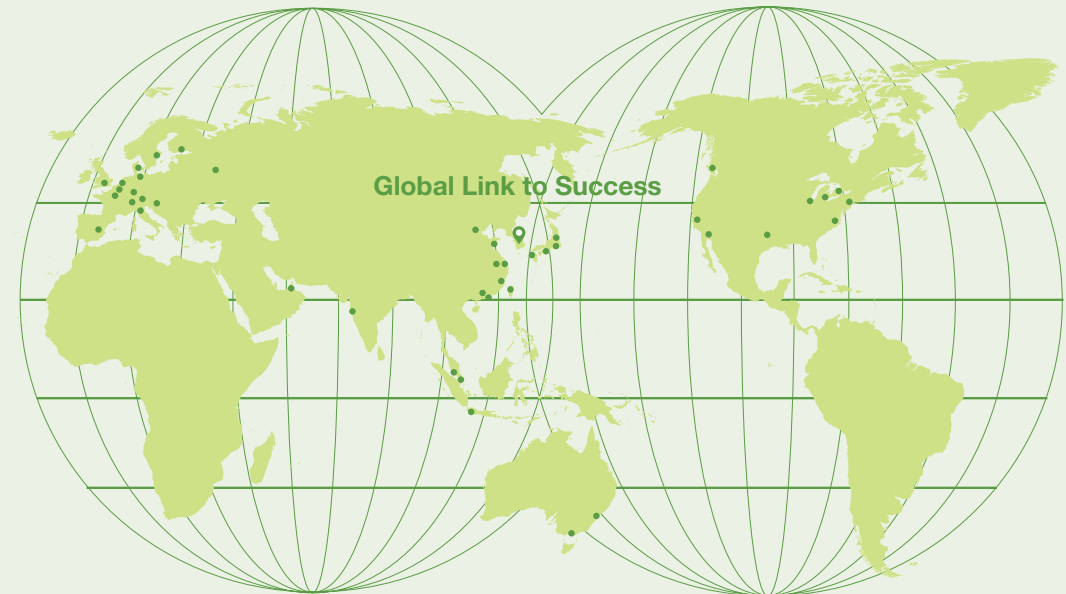
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