

THE PATH TO A CARBON-FREE ISLAND



JEJU - REPUBLIC OF KOREA

**SUSTAINABLE
DEVELOPMENT GOALS**

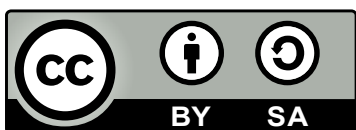
IN COLLABORATION WITH:



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TABLE OF CONTENTS

04	SYNOPSIS
05	BACKGROUND
05	CHALLENGE
06	TOWARDS A SOLUTION
11	LESSONS LEARNED
13	LOCAL BENEFICIARIES AND RESULTS
14	PROJECT FINANCING
16	SCALING UP
17	CONTACT FOR FOLLOW UP
17	RESOURCES

SYNOPSIS

This case study presents the measures the Republic of Korea is taking to reduce its dependence on fossil fuels and become home to the world's first carbon free island. To overcome its energy shortage, Korea imports more than 95 percent of energy resources from abroad. In 2016, Korea ranked 8th among the biggest energy consumers and 7th among the largest greenhouse gas emitters in the world. As part of the solution to its greenhouse gas emissions, the Korean government announced at the Paris Climate Conference that it would join international efforts to reduce greenhouse gas by lowering its emissions by 37 percent by 2030. To act on its commitment, the government selected Jeju province, the largest island off the coast of the Korean Peninsula to serve as a test-bed for clean energy solutions. The aim is for the Island to convert 100 percent of its vehicles and 100 percent of its electricity generation to renewable energy. In addition, the government has designated Jeju to be a demonstration site for a smart grid project that tests the development of smart grid business models and the most advanced smart grid technologies and related research and development (R&D) results.

If the project is successful, its full-scale commercial applications would be transferred to the entire country. The participating companies have begun to commercialize their green technologies globally. However, it is an ambitious plan because currently, renewable energies are only about 5% of the total electricity supply on Jeju Island.

Despite these challenges, the reforms Jeju is taking include measures to replace fossil fuels with power generated by wind via land and sea turbines; plus that from solar energy, small hydropower and electrical storage facilities. The Island is also installing smart grid technologies that collect data on energy use and demand to improve efficiency in energy production and consumption. The key drivers of this transformation are new partnerships by which government agencies and private sector companies collaborate to turn Jeju into a carbon free island. The benefits are projected to include the creation of 40,000 jobs and the reduction of Jeju's greenhouse gasses by 90 percent. Inhabitants are experiencing a dramatic reduction in electricity costs; the number of tourists has increased as has the number of youth attracted to the island by increasing jobs. The project is implemented in three interrelated phases. The first phase consists of experiments on wind and solar power generation conducted on the smaller Gapa Island. The second phase experiments on raising the share of renewables on the energy market, while the third phase is focused on turning Jeju into a carbon free island and a green growth city by 2030.

After the Korean government shared information on the Jeju project during the Paris Climate Change Conference and at the Davos World Economic Forum, as many as 2,400 cities around the world have expressed interest in its replication. The smart grid technologies tested in Jeju are also spreading to markets in developed and developing countries around the world.



BACKGROUND

Addressing climate change is one of the 17 Sustainable Development Goals (SDGs) set by the United Nations in 2015. The Paris Agreement is a complimentary instrument to the SDG's goal 13, focused on “urgent action to combat climate change.” Climate change is already having a profound and alarming impact worldwide. In addition to rising sea levels and global temperatures, extreme weather events are becoming more common. Global emission of CO₂ has increased almost 50% since 1990. If not addressed promptly, it will adversely impact initiatives across all 17 SDGs—increase poverty, reduce economic productivity, diminish health and well-being and undermine development.

CHALLENGE

To overcome its energy shortage, Korea imports more than 95 percent of energy resources from abroad. In 2016, Korea ranked 8th among the biggest energy consumers and 7th among the largest greenhouse emitters in the world. As part of the solution to greenhouse gas emissions, the Korean government announced at the Paris Climate Conference that it would join international efforts to reduce greenhouse gasses by reducing its emissions by 37 percent by 2030.



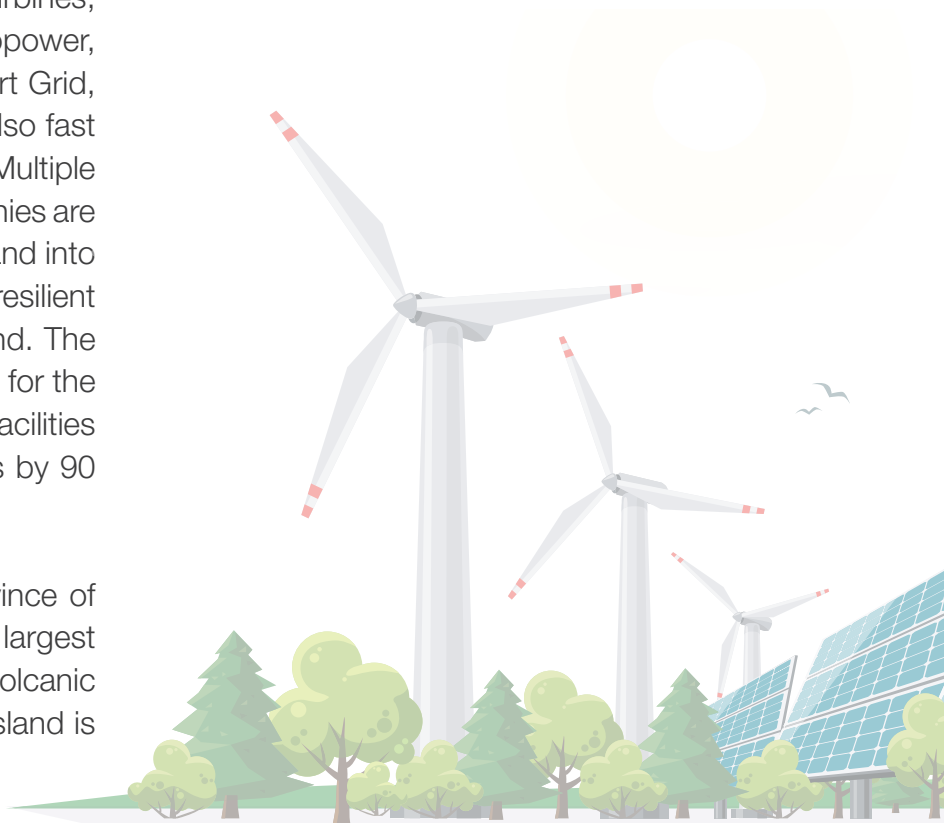
TOWARDS A SOLUTION

To act on its commitment, the government selected Jeju, the largest island off the coast of the Korean Peninsula to serve as a test-bed for clean energy solutions. The aim is for the Island to convert 100 percent of its vehicles and 100 percent of its electricity generation to renewable energy. In addition, the government has designated Jeju to be a demonstration site for a smart grid project that tests the development of smart grid business models and the most advanced smart grid technologies and related R&D results.

By 2030, Jeju Island plans to become carbon free and fully sustainable by using renewable energy. The plan is to substitute existing fossil fuels by utilizing wind via land and sea turbines, plus the use of solar energy, small hydropower, and electrical storage facilities. The Smart Grid, an improved electricity supply chain, is also fast becoming a new green growth engine. Multiple government agencies and private companies are forming partnerships to transform the island into an energy independent, climate change resilient and ecologically sound zero-carbon Island. The project is expected to create 40,000 jobs for the construction and maintenance of the facilities and to reduce Jeju's greenhouse gases by 90 percent.

Jeju Island is the only autonomous province of the Republic of Korea and the country's largest island. It was formed by lava flows from volcanic eruptions over 2 million years ago. The island is

known for its picturesque beauty and volcanic craters. It measures approximately 41 km (25 miles) from north to south and 73 km (45 miles) east to west and its home to 600,000 Koreans. Jeju attracts more than 15 million tourists on an annual basis and the tourism service sector covers 75% of the island's industrial structure. The island has received impressive environmental accolades which include those by the Biosphere Reserve (2002), the UNESCO World Natural Heritage (2007), the Global Geoparks Network (2010) the four Ramsar Wetland designations (2006-2011) and the New7Wonders of Nature (2011). Jeju has thus become a 'treasure island of environmental assets' that the world has to preserve.





Carbon Free and Renewable Energy

The sunny and windy climate makes Jeju Island an ideal location to test the concept of becoming fully sustainable by using renewable energy. The Island attracts a lot of wind due to its geographical location. The islanders used to make huge efforts to resist the wind which is used today to generate electricity for every house on the island.

The Island's first demonstration project for wind power generation which started operation in 1995 was constructed by the Korea Institute for Energy Research (KIER), the national research

laboratory. In 2003, the first major wind farm was installed on the island and the country's first commercial-scale offshore wind farm first delivered power in 2017. Under the slogan, "Carbon Free Island Jeju," the project plans to expand wind turbine capacity by 2030 to 2.35 gigawatts—a 15-fold increase from the turbines' current output of 156 megawatts, with continuing support from KIER technology. Furthermore, Jeju plans to use the wind power to switch to electric cars; and it aims to make all its vehicles electric.



Jeju Island's switch to carbon-free energy is being implemented in three phases:

Phase 1

Build Gapa Island, small island south of Jeju Island and home to 177 people, into a carbon-free island and a model for the rest of Jeju.

Previously, Gapa Island received its power from diesel generators which produced more than 780-tons of Green House Gas (GHG) daily. In cooperation with local and central government agencies, two wind power generators were installed and 49 of the 97 houses have solar panels on the roof. The island produces more energy than its residents consume. The extra energy produced is stored in smart devices on the electricity grid for the days when weather conditions disrupt solar and wind power generation. The island is now 100% powered by new and renewable energy. Further helping the island to become carbon-free is the limited number of cars. The most common modes of transportation are walking and cycling. There are only nine cars on the island, four of which are electric.

Phase 2

Raise share of new and renewable energy in the energy market to 50% by 2020.

Based on projections, wind and solar power sources can supply approximately 6,561 gigawatt-hours of electricity which is more than the total amount used on Jeju Island. By 2020, one gigawatts offshore wind power, 350 megawatts inland wind power, and 30 megawatts solar power will be installed, equivalent to 68% of Jeju's total electricity demand of 5,268 gigawatt-hours.

Phase 3

Make Jeju Island a world class carbon free and green growth city by 2030.

The plan is to raise offshore wind power generation to 2 gigawatts and solar power generation to 100 megawatts. Additionally, the plan includes raising the use of electric vehicles from the current number of 852 to 377,000 by 2030, and to install 225,000 rechargers across the island. Furthermore, laws and regulations will be eased to incentivize the widespread use of electric cars.

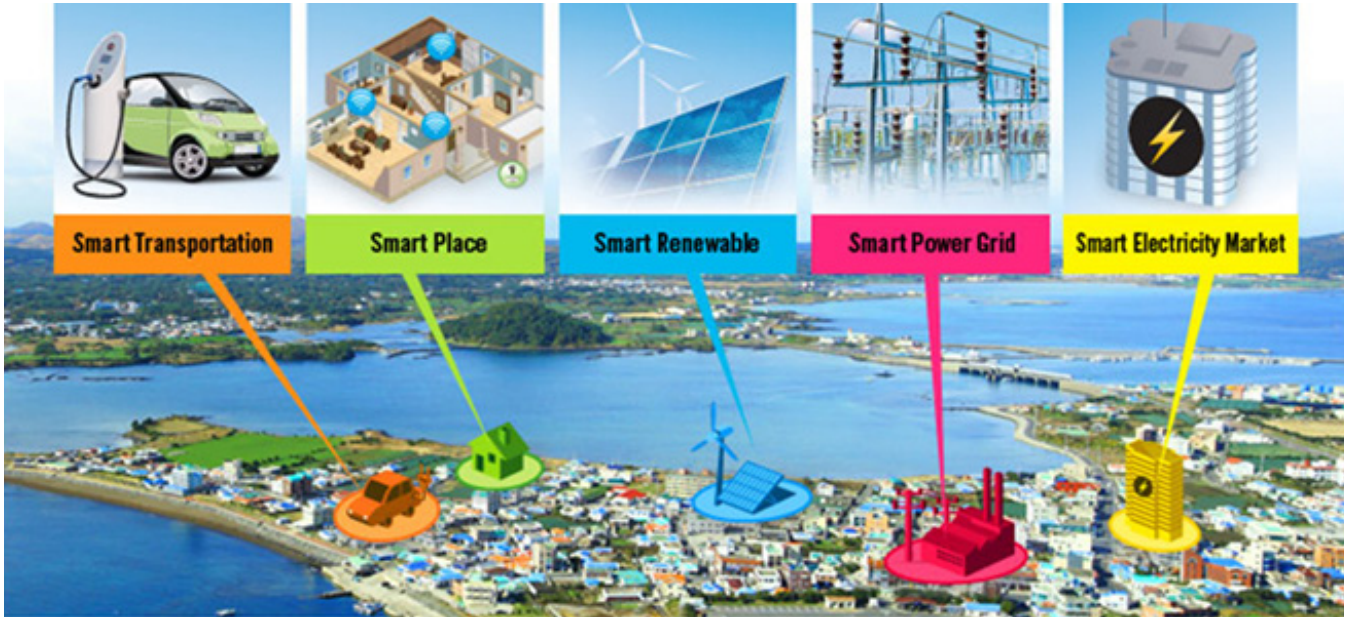


Smart Grid Test-Bed & Zero Emission Mobility

Because the Republic of Korea pursues sustainable development to address climate change, it is shifting toward a low carbon economy. As part of these efforts, Korea launched a Smart Grid project to achieve green growth in a transparent, comprehensive, effective, and efficient way. Accordingly, Korea came up with a proactive and ambitious plan to build a Smart Grid Test-bed on Jeju Island. In 2009, the Jeju project was inaugurated with the participation of 12 consortia consisting of 168 companies, which cover approximately 6,000 households. KIER also established its own Jeju Global Research Center to work on the application of renewable energy sources and to support the smart grid program.

South Korea has ambitions to be a world leader in smart grid technology. The smart grid is an intelligent power transmission and distribution system that collects real-time data on energy usage and demand. Power consumption and cost can be checked immediately to avoid unnecessary use of electricity, target favorable hours for electricity use to lower costs and to effectively deal with the wind and solar power fluctuations. The system could optimize efficiency in electricity generation and consumption. This would increase the quality of life by predicting how much energy should be generated in advance to meet demand. That way, wastage would be minimized, CO2 emissions would be abated, and global warming would be prevented.

The Jeju test bed is composed of five main showrooms and test facilities:



AREA	GOAL
SMART TRANSPORTATION	To build a nationwide charging infrastructure for electric vehicles
SMART PLACE	To encourage consumers to save energy by using real-time information and producing smart home appliances
SMART RENEWABLE	To build a smart renewable energy power generation system by rolling out micro grids
SMART POWER GRID	To build a reliable and high-quality power supply system
SMART ELECTRICITY SERVICE	To improve consumers' right-to-choose by satisfying their various needs, and provide electricity-ICT combined services



LESSONS LEARNED

There is undoubtedly some skepticism around the Korean government's ambitious goal of making Jeju the world's first carbon free island. Although the vision and the roadmap are impressive, some experts doubt whether the project would be completed on the proposed timeline. Additionally, the following concerns have been raised.

1. **Emission Reduction Target:**

Achieving carbon freedom by 2030 is deemed very challenging since renewable energy makes up only 5% (as of June 2016) of the total electricity supply on Jeju Island.

2. **Public Acceptance:**

Although citizens have a positive opinion about renewable energy, they react negatively when these developments are planned in the backyard of their respective communities. It is crucial to involve citizens from the planning stage, discuss the costs and benefits of the project, management responsibilities, etc.

3. **Growing Pain Of Rapid Development:**

It is important to focus on improving the living standards of Jeju residents, while making efforts to develop a model city for sustainable development. In this regard, the Jeju provincial government has established programs to protect and help residents—curbing real estate speculation, mass transit system improvements, and prevention of reckless land development without considering the environmental impact.

4. **Conservation vs. Development:**

Due to this innovation, the number of tourists increased even more in recent years, boosting the island's economy. But the island's commercial success has come at a steep cost. Traffic jams, overwhelming amount of garbage and noise have become a part of Jeju life. The island's underground water has recently been found to be "in danger of being exhausted." Jeju residents complain that the increased number of visitors has damaged the island's once pristine environment that attracted them in the first place.

5. **Conflicts between Solar Farming vs. Food Security:**

Jeju's provincial government announced a plan to offer solar power business opportunities to outdoor tangerine farming communities. The government's plan guarantees a fixed income for 20 years for the sale of electricity generated by the new solar power plant. It is an attractive offer for the farmers because the profits generated by running a solar power plant are much higher than those from citrus farming. Although it is still in early stage, this plan could cause problems if it draws in too many farmers and too much land. Solar farming means producing solar energy, to increase the island's energy independence, instead of producing food crops which could possibly lead to food insecurity concerns and even conflicts between farmers.

6. **Unstable Weather Conditions:**

It is an inevitable problem with solar and wind power. Jeju is known for its sunny and windy climate but the summer season always poses challenges because the summer monsoon (raining season) begins in June or July and the wind is not as strong on the island during the summer when electricity use increases. Energy storage systems are an essential part of renewable energy generation but need scaling up to conveniently and efficiently store and supply energy when its needed.



LOCAL BENEFICIARIES AND RESULTS

Since the energy self-sufficiency project began, the lives of Gapa island residents have changed dramatically. The two wind turbines generate 500 Kwh, and 49 solar panels on rooftops produce 174 Kwh. Because Gapa residents use 230 kwh at most, the renewable energy is more than plenty to run the entire island. The unused energy is stored in an energy storage system (ESS) for later use.

The wind and solar power generators are connected to a smart meter and smart system on the electricity grid. The energy supply and consumption of the entire island is controlled at a micro-grid operation center in the center of Gapa Island. The center monitors the wind turbines, solar panels and diesel generators, and the island's overall energy production and consumption. The Mayor of Gapa said, "At first, we were not satisfied with the results of renewable energy. Now, though, it is benefiting us in two ways: our electricity bills are lower, and the number of tourists is higher."

1. The houses that were fitted with solar panels and energy efficient power generators saw their utility bills fall from \$33-\$42 per month to \$.90-\$2.00 per month. The Island's public schools also benefitted from the new supply of renewable energy since they can enjoy digital devices at an extremely low cost. Moreover, at the end of the month, the power that is accumulated but not used through the solar panels is sold to the power company, potentially saving homeowners even more money.

2. Over the years, the island's population was in decline, as young people left in search of jobs—the youngest working resident on the island is 51 years old. In the 1970s, the island had a population of more than 1,000; today that figure is down to 170. As "Gapa Project" started to draw global attention, the number of visitors increased—rising from 10,000 in 2008 to 40,000 in 2011 to 110,000 in 2015. This created jobs other than the traditional fishing, which not only helped residents but also brought back those who had left for jobs elsewhere.

PROJECT FINANCING

Jeju Island is a Special Self-Governing Province of South Korea, exclusively conducting its own special policies such as the Jeju Investment Promotion Zone (tax incentives for investors), the visa waiver for 180 countries, Duty Free Shopping (DFS) for domestic travelers, etc. Jeju Island is inviting a wide range of businesses to invest in the project, which will require an estimated 6 trillion won (\$5.46 billion) in investment by 2030.

Gapa Island Renewable Project:

The Jeju Special Self-Governing body has invested \$12.5 million to help Gapa become carbon-free. Along with two 250 kW wind turbines which cost \$8.6 million, 174kW solar panels were installed in 49 households in May 2017. The Jeju government subsidized the installation of solar panels on houses—residents pay only 10% of the total approximate cost of \$12,000. Other installations include an energy storage device, a system control center, power conversion equipment and remotely controlled power meters. The electricity produced in this way powers the households on the island, four electric cars and a desalination plant.

From the private sector, the area received \$88.6 million from Korea Electric Power Corporation (KEPCO), Korea Southern Power Company (KOSPO), Woojin Industrial Systems and Shin-Kobe Electric Machinery. As the project gained momentum, Gapa received an additional \$1.25 million in funding from the Seoul national government for a 1,000 KWh lithium-ion battery and a 1,000 KW power converter.

Jeju Wind Farm Project:

Jeju Island Self Governing Province created Jeju Energy Corporation (JEC) to help the island reach its target of becoming Carbon Free by 2030. Since its establishment, JEC has announced its intention to support the island's offshore wind industry. Existing offshore wind installed capacity consists of 5 MW test-beds that are developed by the KIER—JEC plans to construct offshore wind generation complexes to produce 100 MW in



optimal conditions by 2020. A total of \$672.5 million is expected to be invested in the project — \$162.3 million for land-based facilities and \$510.2 million for offshore facilities. The planned infrastructure is expected to produce 591,300MWh of electricity every year while reducing CO2 emissions by 272,000 tons annually. Any surplus offshore wind-generated electricity will be exported to the Korean mainland; however, it is not yet clear how much excess there will be. The JEC also plans to develop 1855MW wind farms on land and at sea by 2030, establishing the foundation to become the environmental capital of the world. JEC is solely funded by Jeju Island Self Governing Province.

Electric Vehicles (EV):

Jeju is a natural fit for EVs. It is a relatively small, oval-shaped island where drivers can travel along the 180 kilometers of coastal roads. A fully charged electric car can travel between 100 to 150 kilometers. Because most people drive an average of less than 100 kilometers daily, the island is the right size for EVs. Jeju Island has spent years building EV infrastructure to encourage residents to make the switch from gas to battery-powered cars. Until 2020, the Jeju government is providing subsidies to EV buyers of up to \$21,800 per car plus an additional \$6,700 and tax incentives. The subsidy is more generous than that offered by most other countries around the world but the price of the automobiles is also higher in Korea. For example, Nissan's Leaf will retail for about \$46,700 in Korea, compared to about \$29,000 in the US and Europe.

Smart Grid Vision:

The South Korean conglomerate plans to use cutting-edge energy and information technology to help the island minimize carbon dioxide emissions by 2030. The centerpiece of the project is a smart grid supported by the computer technology designed to control the Island's power supply for maximum energy efficiency.



This is being carried out by a consortium of companies including SK Telecom, Korea Telecom (KT), LG Electronics, Hyundai Heavy Industries and KEPCO. It is the 20-year vision of the Government of the Republic of Korea to see its \$58.3 billion electricity market connected in a smart grid and to win 30% of the global smart grid market, estimated between \$20 billion to \$160 billion for its home industries. The deployment of the smart grid will save the country about \$10 billion a year in energy import costs and it

will reduce the country's CO2 level by 30%. The total budget for the pilot project is \$876 million, about \$400 million of which will come from central and local governments and the rest from the private sector. KEPCO alone has invested \$155 million. In addition to providing smart meters, an EV charging infrastructure, and energy storage, KEPCO is piloting a smart

grid station that will provide sophisticated energy management and grid integration for commercial buildings.

SCALING UP

Jeju Island's Carbon Free project has attracted attention from participants at the Paris Climate Change Conference and the Davos World Economic Forum. The strategy is recognized as a model new energy policy that can be applied nationally but also to 2,400 cities around the world.

Domestically:

Currently, Gapa test results are being applied to other small Islands around the country, including Gasa Island. Plans are in the works to also transform 63 more remote insular areas, including Ulleungdo and Deokjeokdo Islands in Incheon. After the Jeju Carbon Free 2030 project is completed, the government plans to gradually extend that success to cities on the mainland.

Internationally:

Gapa Island's "Micro-Grid" pilot project is becoming a new example for many countries, including Indonesia, the Philippines, UAE and Canada. The case study is scheduled to be applied to the Marañón River and the Pastaza River in northern Peru. The lack of power grids there has caused the locals to resort to

logging and fossil fuels, which have increased greenhouse gas emissions. Furthermore, the Korean government's vision of turning Jeju into the world's largest smart grid test-bed enables participants to test cutting-edge smart grid technologies and to export them abroad. This has helped some Korean companies to take a leap ahead in the commercialization of such smart technologies. KT already deployed its Smart Grid Network Operating Center (NOC) technology in Finland and Uzbekistan and developed pre-commercial services for 50 homes in Bahrain. LG Electronics introduced smart home appliances based on smart grid technology. SK Telecom also plans to expand into the overseas markets for smart grid-related ICT.

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RESOURCES

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