KEPCO’s Carbon Neutrality Strategies

2023.06
ByoungDoo Kong
Countries need customized CO₂ reduction measures to achieve carbon neutrality, and they are commonly face Energy Trilemma*.

* Energy security, Energy equity and Environmental sustainability

Korea plans to decarbonize Energy Transformation, Industry, Transportation and Building sectors, which account for the majority of GHG emission, to achieve carbon neutrality by 2050.
Carbon Neutral Scenario

(Unit: Million ton CO₂-eq)

※ Presidential Commission on Carbon Neutrality & Green Growth will revise the Carbon Neutrality Scenario.
# CO₂ Reduction Plan

## Energy Transformation
- Increase the portion of renewable power
- Low-carbon fuel & nuclear energy

<table>
<thead>
<tr>
<th>Year</th>
<th>CO₂ Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>269.6 million tCO₂eq</td>
</tr>
<tr>
<td>2050</td>
<td>0 million tCO₂eq</td>
</tr>
</tbody>
</table>

## Industry
- Steel: HyREX (Hydrogen Reduction)
- Cement: Plastic Waste Pyrolysis and Hydrogen

<table>
<thead>
<tr>
<th>Year</th>
<th>CO₂ Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>260.5 million tCO₂eq</td>
</tr>
<tr>
<td>2050</td>
<td>51.1 million tCO₂eq</td>
</tr>
</tbody>
</table>

## Transportation
- Expansion of EV & FCEV charging stations
- Cargo transportation (road → rail and ship)

<table>
<thead>
<tr>
<th>Year</th>
<th>CO₂ Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>98.1 million tCO₂eq</td>
</tr>
<tr>
<td>2050</td>
<td>2.8 million tCO₂eq</td>
</tr>
</tbody>
</table>

## Building
- Zero-energy Building 100%
- Supply of high efficient equipment

<table>
<thead>
<tr>
<th>Year</th>
<th>CO₂ Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>52.1 million tCO₂eq</td>
</tr>
<tr>
<td>2050</td>
<td>6.2 million tCO₂eq</td>
</tr>
</tbody>
</table>
## Vision of the Power industry

<table>
<thead>
<tr>
<th>Present (2020)</th>
<th>Future (2050)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Generation</strong></td>
<td>Zero-emission fuel</td>
</tr>
<tr>
<td>Fossil fuel Power Generation</td>
<td>- Renewable energy (60.9 ~ 70.8%)</td>
</tr>
<tr>
<td>- Coal · LNG: 62.0%</td>
<td>- Zero emission fuel gas turbine (13.8 ~ 21.5%)</td>
</tr>
<tr>
<td>- Renewable energy: 6.6%</td>
<td>- CCUS (55.1 ~ 84.6 million tons)</td>
</tr>
<tr>
<td><strong>Power Grid</strong></td>
<td>Bi-directional &amp; distributed power grid</td>
</tr>
<tr>
<td>One-way &amp; centralized power grid</td>
<td>Distributed power system</td>
</tr>
<tr>
<td><strong>Energy Consumption</strong></td>
<td>Power consumption: 1,213.7TWh</td>
</tr>
<tr>
<td>Power consumption: 509.3TWh</td>
<td>Society that is self-sufficient and highly efficient in terms of energy</td>
</tr>
<tr>
<td>Low Efficiency of Energy Consumption</td>
<td></td>
</tr>
</tbody>
</table>
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KEPCO’s Key Roles for Carbon Neutrality
# KEPCO’s Key Roles for Carbon Neutrality

## Vision
Lead the decarbonization of the energy sector by 2050

<table>
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<tr>
<th>Strategy I</th>
<th>Decarbonization</th>
<th>Strategy II</th>
<th>Decentralization</th>
<th>Strategy III</th>
<th>Research &amp; Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decarbonization of electricity production</td>
<td>Building a futuristic Electrical Grid for Green Energy</td>
<td>Development of carbon-neutral core technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Promote decarbonization in electricity production by expanding the renewable energy and hydrogen power generation</td>
<td>- Play a major role in achieving carbon neutrality by reinforcing the electricity grid and optimizing its operation</td>
<td>- Lead the development of core technologies for carbon neutrality by forming solidarity and cooperating with others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Promote decentralization of electricity production and demand</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
KEPCO’s Key Roles for Carbon Neutrality

Strategy 1

“Decarbonization of electricity production”

Renewable Energy

- Take the lead in expanding the renewable energy
  - Large-scale project development, such as offshore wind farms and floating solar panels.

Hydrogen Power Generation

- Transition to Zero-Carbon energy (Hydrogen & Ammonia) by 2050
  - Replacement of coal and natural gas with those mixed respectively with ammonia and hydrogen to produce electricity.
### Offshore Wind Farm Projects

#### Southwestern Test Bed
- **Capacity**: 60MW
- **Status**:
  - In Operation
  - Fully commissioned in 2020

#### Southwestern offshore Wind Farm
- **Capacity**: 1.2GW
- **Status**: Under development
- **Milestones**:
  - 2022 - 23: Wind Measurement Campaign
  - 2026 - 30: Construction
  - 2029 - 30: Commencement of Commercial Operation

#### Shinan offshore Wind Farm
- **Capacity**: 1.5MW
- **Status**: Under development
- **Milestones**:
  - 2021 - 23: Wind Measurement Campaign
  - 2028 - 32: Construction
  - 2031 - 32: Commencement of Commercial Operation

#### Jeju Hanlim offshore Wind Farm
- **Capacity**: 100MW
- **Status**:
  - Under Construction
  - Plan to achieve COD in 2024
Photovoltaic generation using idle sites for efficient use of the land and promotion of renewable energy
### H₂ and NH₃ Power Generation Projects

<table>
<thead>
<tr>
<th>Strategy 1</th>
</tr>
</thead>
</table>

#### Coal Plant

<table>
<thead>
<tr>
<th>R&amp;D, Deployment</th>
<th>Commercialization</th>
<th>NH₃ &amp; H₂ Fired Power Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>20% Ammonia Co-firing Applied to 4 plants</td>
<td>20% Ammonia Co-firing Applied to 8 plants</td>
<td>Ammonia Firing for 7 Power Plants</td>
</tr>
<tr>
<td>~ 2028</td>
<td>2030</td>
<td>2050</td>
</tr>
</tbody>
</table>

**Expected Demand (Unit :10k ton)**

<table>
<thead>
<tr>
<th>Year</th>
<th>NH₃ Ammonia Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>296</td>
</tr>
<tr>
<td>2050</td>
<td>1,100 ~ 1,300</td>
</tr>
</tbody>
</table>

#### Gas Turbine

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<thead>
<tr>
<th>R&amp;D, Deployment</th>
<th>Commercialization</th>
<th>NH₃ &amp; H₂ Fired Power Plant</th>
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<tbody>
<tr>
<td>50% Hydrogen Co-firing Applied to 2 Plants</td>
<td>50% Hydrogen Co-firing Applied to 13 Plants</td>
<td>Hydrogen Firing for More Than 34 Power Plants</td>
</tr>
<tr>
<td>~ 2028</td>
<td>2030</td>
<td>2050</td>
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**Expected Demand (Unit :10k ton)**

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<tr>
<th>Year</th>
<th>Hydrogen Demand</th>
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<td>2050</td>
<td>1,150 ~ 1,300</td>
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KEPCO’s Key Roles for Carbon Neutrality

“Building a futuristic electrical grid for green energy”

Construction of Transmission Network

- Pursuing legislation of Planned Site Selection System
  - Prevent disorderly and inefficient land development and promote efficient use of renewable energy

Renewable Energy Operation

- Establish the measures to strengthen the system stability
  - Establishment of integrated control system (forecast, monitoring and control) for renewable energy, etc.
Build a planned site that fully considers the system and location conditions for an orderly and scalable distribution of renewable energy.

- **Stage 1** Zone: Comprehensive consideration of electricity demand and renewable energy potential
- **Stage 2** Site: Discovery of candidate sites in connection with the local public electricity grid
- **Stage 3** Tender: Contest for transmission rights (capacity and time) linked to KEPCO’s grid construction
Distribution of Regions in Electricity Demand

Concept

- Prevent inefficient investment in the infrastructure and optimize the electricity consumption by distributing the demand for electricity in the metropolitan areas.

Map of Renewable Energy Sufficiency

- Provides data on the grid’s regional availability to accept the renewable energy power generators and information on the connection facilities.

Energy Independence

- Provide comprehensive incentive packages, such as a broader voltage options and reduced cost especially for the newly established data centers.
Increase the stability of the power system by resolving the volatility of renewable energy through real-time information sharing between renewable energy generators, integrated renewable energy monitoring system operator and KEPCO, the transmission and distribution manager.

- Manages PV and Wind power plants and accumulates facility data for the prediction of renewable energy output.
- Integrated control system for distribution grid and renewable energy.
KEPCO’s Key Roles for Carbon Neutrality

"Development of Carbon-neutral core technology"

**R&D for Carbon Neutrality**

- **Initiate the development of core technology**
  - Efficient energy use, expansion of renewable energy, transition to zero carbon fuel, intelligent electricity grid, etc.

- **Innovate the R&D process**
  - Expansion of open innovation and challenging task selection, etc.

<table>
<thead>
<tr>
<th>Energy efficiency</th>
<th>Renewable energy expansion</th>
<th>Fuel transition</th>
<th>Intelligent power grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-efficient low-loss technology, such as HVDC</td>
<td>Expansion of wind power plants and reduction in costs of operation</td>
<td>Mixed and single firing of hydrogen and ammonia for power generation</td>
<td>Expansion of renewable energy and development of optimized ESS</td>
</tr>
<tr>
<td>Provision of customized xEMS solution</td>
<td>Expansion of green hydrogen using the surplus renewable energy</td>
<td>Commercialization of CO₂ capture and utilization technology</td>
<td>Digital transition of transmission and distribution management system</td>
</tr>
</tbody>
</table>
R&D for Carbon Neutrality

Energy Efficiency
- Distributed electricity supply chain
- Monitoring and control of the broad area system, electricity grid by the region, AC/DC composite network
- High efficient transmission system
- HVDC, MV · LVDC, superconductivity
- Building efficiency
- xEMS platform, demand data inspection and prediction
- Industry efficiency
- Integrated system for energy saving, electrification
- Transport efficiency
- Technology to advance EV charging stations and P2G

Expansion of Renewable energy
- Offshore wind power
- Low cost and large-scale complex technology
- Photovoltaic power
- Manufacture highly efficient PV cell elements
- Production/storage/use of hydrogen
- Production by electrolysis, mass storage and fuel cell technology

Fuel Transition
- Hydrogen power generation
- Technology to improve dual fuel rate of hydrogen and dual fuel and firing technology
- Ammonia power generation
- Ammonia dual fuel and firing technology using existing coal power plants
- CCUS
- CO₂ Capture, Utilization and Storage technology

Establishment of Intelligent Grid
- Increasing penetration of renewable energy
- Monitoring, prediction, and control of renewable energy, and technology related to power system inertia
- Large capacity ESS
- By assisting the frequency adjustment, ESS to ease renewable energy output variation
Chapter II

Cooperation Model
# Joint development of Global hydrogen business

## Background

- **Southeast Asian countries** have a favorable renewable energy environment but need to develop technologies.
- **Korea and Japan** have a limited renewable energy environment but possess sufficient technologies.
- A significant demand for green hydrogen is anticipated in Korea and Japan.

## Cooperation Model

<table>
<thead>
<tr>
<th>Southeast Asia</th>
<th>Korea and Japan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Establishment of renewable energy infrastructure by importing the hydrogen-related technology and exporting the fuel (hydrogen)</td>
<td>1. Securing the fuel (green hydrogen) from overseas and diversifying the source countries</td>
</tr>
<tr>
<td>2. Foundation of a basis for application of renewable energy and vitalization of carbon neutrality</td>
<td>2. Minimize transportation costs and carbon intensity (CO₂ emissions per a unit of hydrogen produced) by importing the clean hydrogen from neighboring countries</td>
</tr>
</tbody>
</table>
Joint development of overseas hydrogen business

Cooperation in Hydrogen Business

Fuel SWAP

☑ Export of hydrogen production technology
☑ Construction of infrastructure in the Southeast Asia

☑ Establishment of renewable energy infrastructure
☑ Production of hydrogen and export to Korea & Japan

Korea

Japan

Southeast Asia
A Smart Energy Creator

Thank You