# Accelerating energy transition in South Korea

*Agora webinar series*

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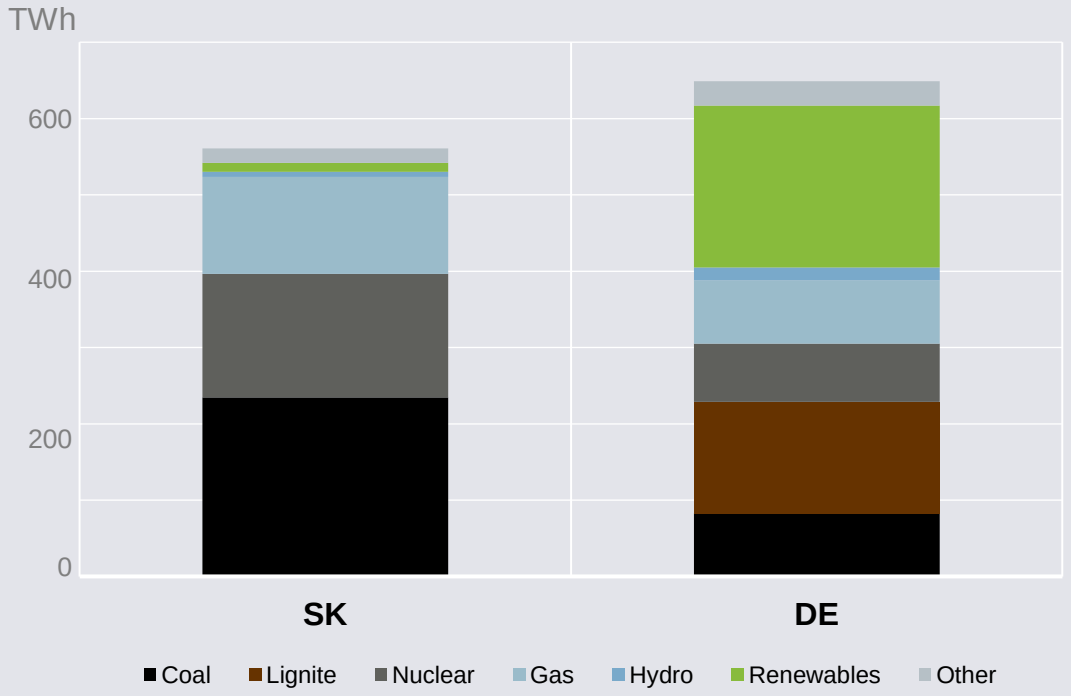
# Korean power system at a glance

# A comparative glance between the German and Korean power mixes shows both similarities and differences

Power generation in Germany and in Korea (2018)



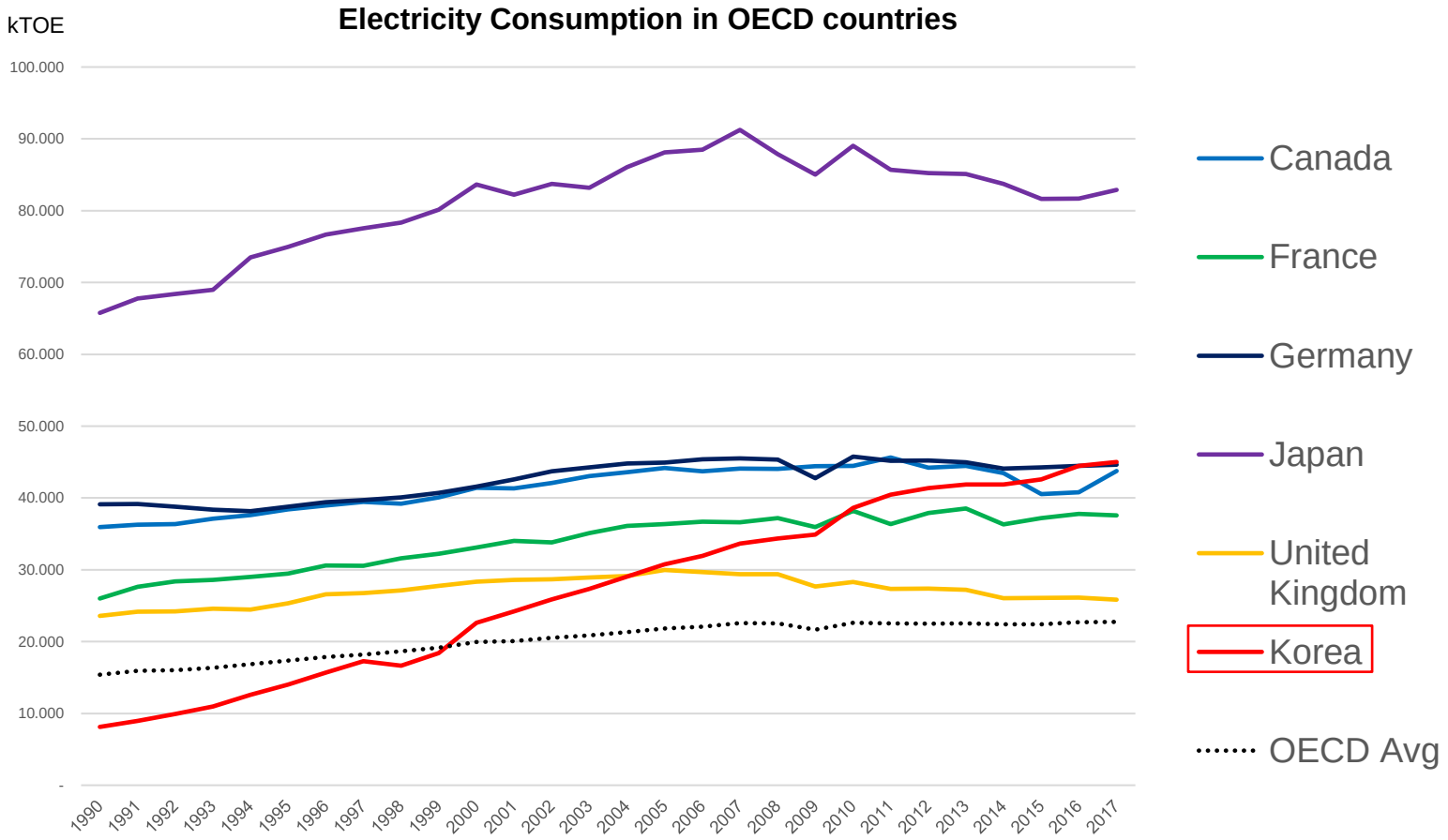

AGEB (2018), Korean Energy Economics Institute (2018)

Comparative indicators between Korea and Germany (2018)

| | KOR | DE |
|---|---|---|
| Yearly power consumption [TWh] | 570 | 643 |
| Maximum peak load [GW] | 80 | 84 |
| Share of coal (hard coal and lignite) [% power production) | 42% | 35% |
| Share of nuclear [% power production] | 23% | 12% |
| Share of vRES [% power consumption] | <3% | 27% |
| Total population [Million] | 51.6 | 82.8 |

AGEB (2018), KEEI (2018), IEA, tradingeconomics

# As an industrial country, Korea energy consumption growth is above OECD average

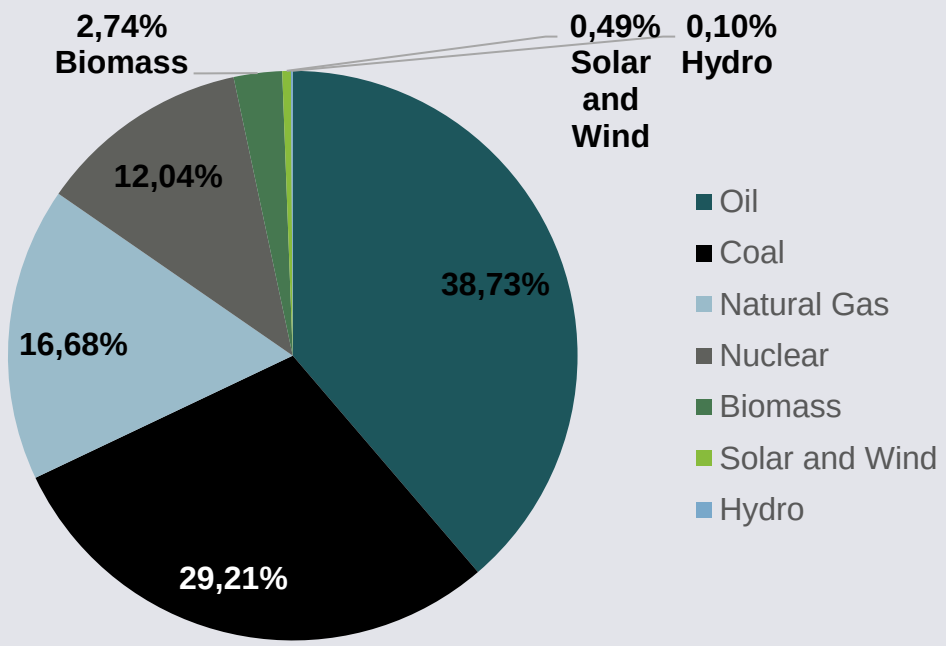



- Final energy consumption increased by 2.7% per year between 2000 and 2017
- Electricity accounts for around 19% of total final energy consumption
- Electricity consumption has doubled in the past 15 years, with annual growth rate 5.5% (2007-2011) and 1.8% (2012-2018)

Source: IEA (2019)

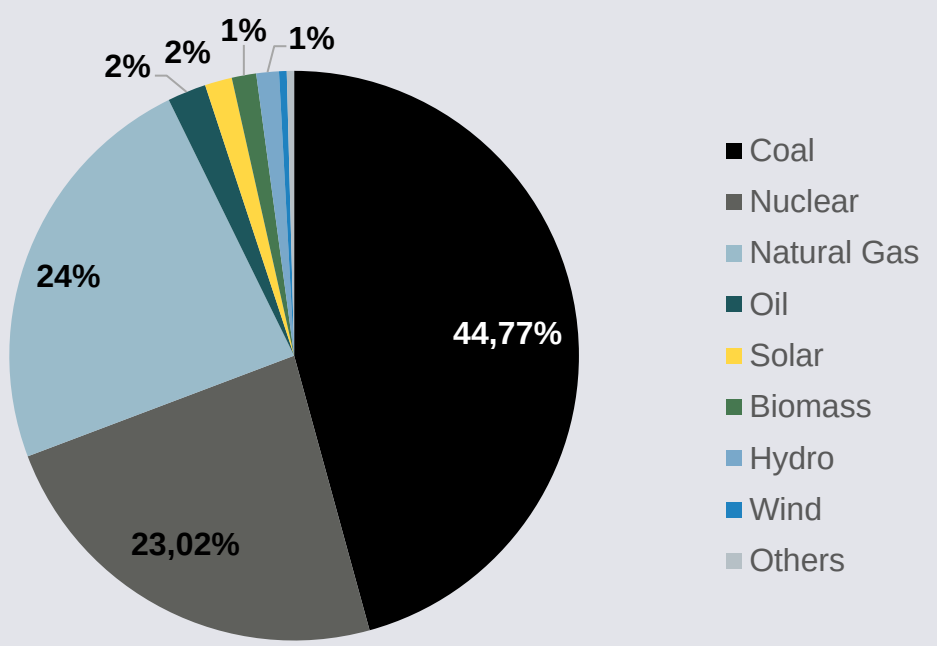
# South Korea is still dominated by fossil fuels

Share of total primary energy supply (2018)



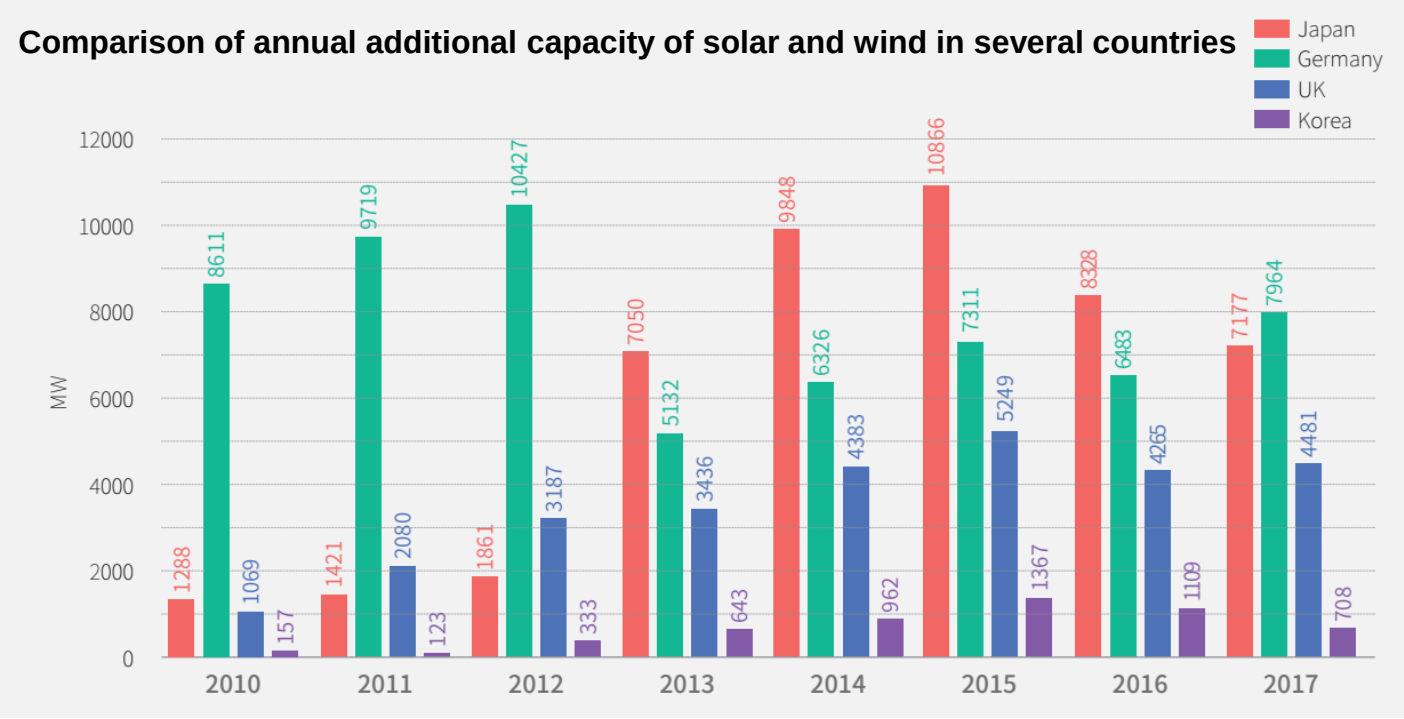

IEA (2018)

Share of electricity generation (2018)




IEA (2018)

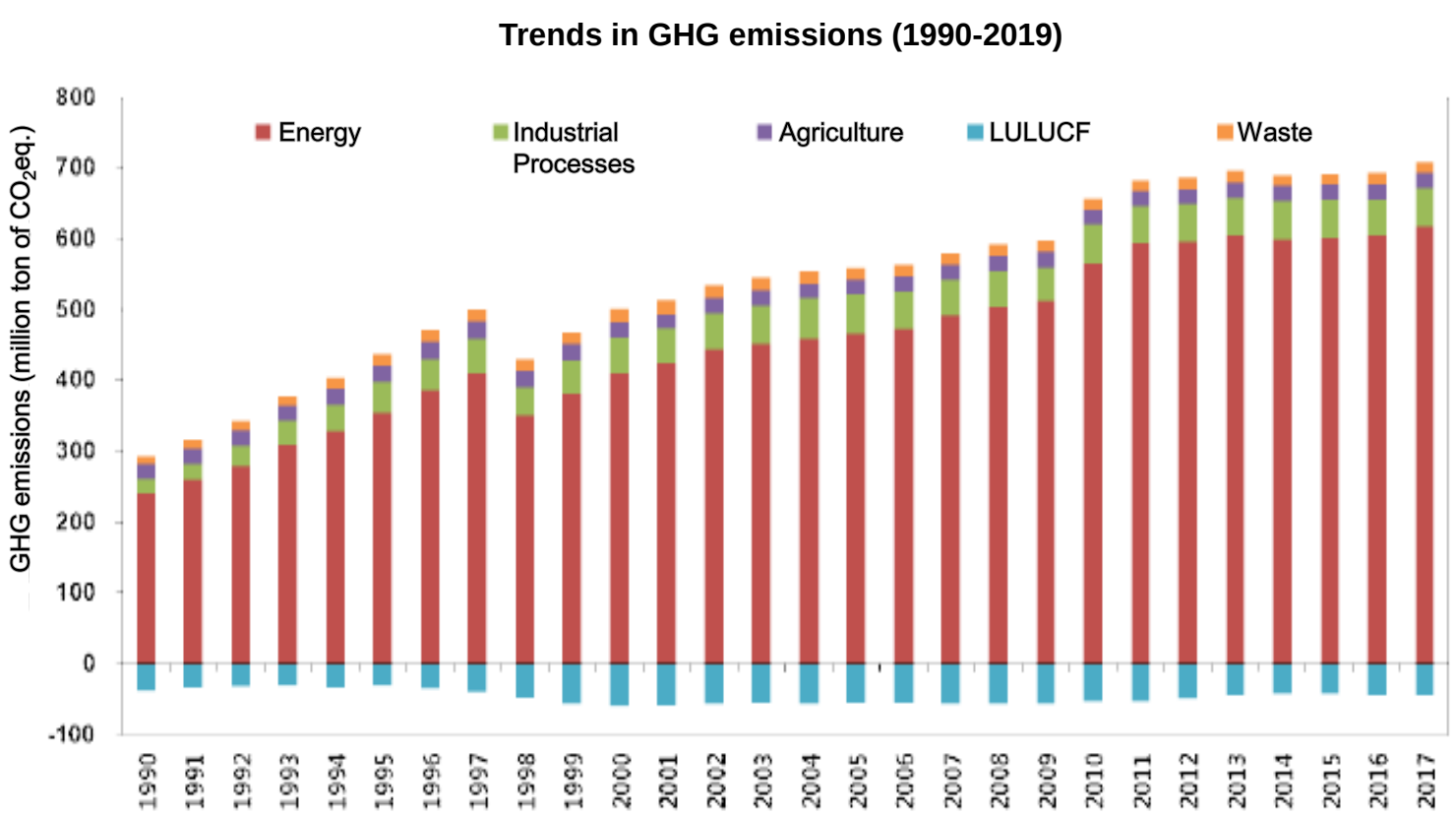
# ….and still sluggish solar and wind capacity




- As an industrialized country, Korea has a notable solar PV market and module producer
- However, up to 2019 only seen a total installation of 9.3GW of PV and 1GW Wind
- Gov. target: RE is 20% share of generation by 2030: PV (37GW), Offshore wind (14GW) and Onshore wind (4GW)
- There are several challenges, but Renewables is expected to increase along with the decreasing global cost

Source: GESI (2019)

# Is the revised emission target in line to reach net zero emission in 2050?




- Emission from energy sector is 87% of total, 55% coming from industry
- The 2014 target has not been achieved in 2020
- In 2018, the government has revised its emission target to 536 $MtCO_2$ by 2030, and 37% reduction from the 2018 BAU scenario (of 850.8 $MtCO_2$)

# Challenges for decarbonising the South Korean energy sector

→ **Land Use and Public Acceptance**

- Land use, complex permitting process, not streamlined regulations
- Negative perceptions towards Renewables

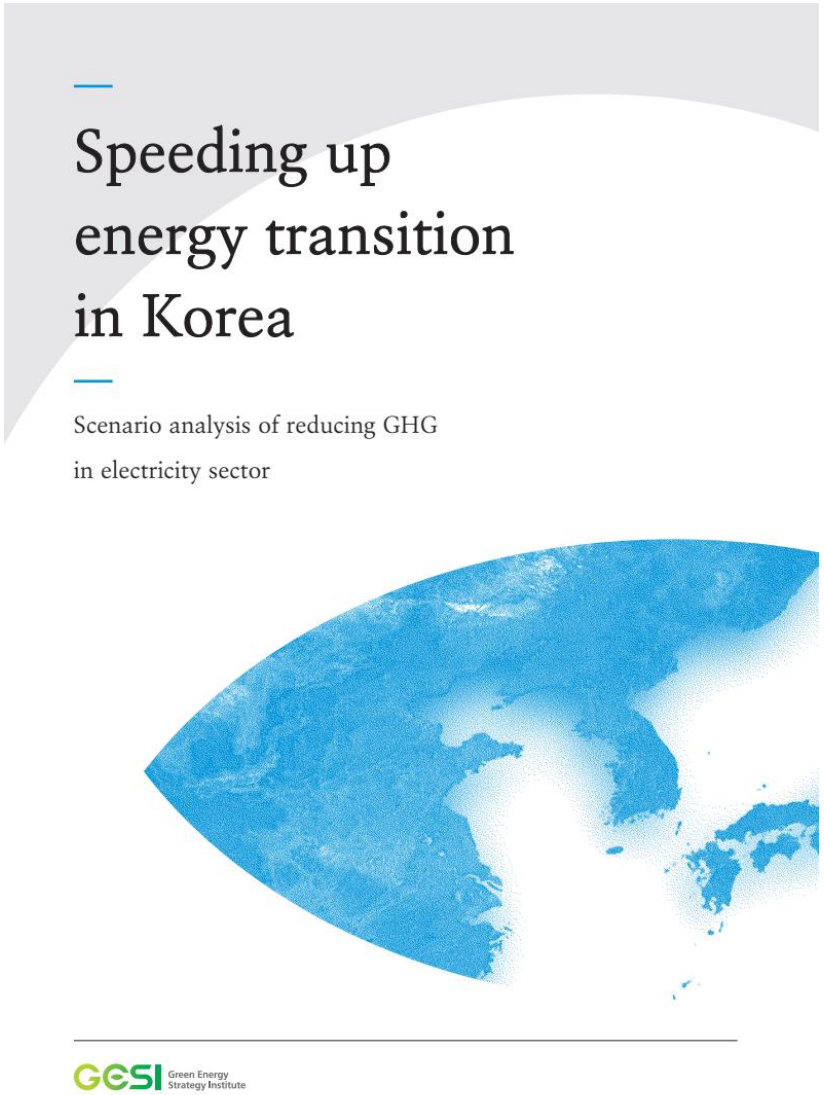
→ **Power Market and Pricing for Renewables**

- Subsidies for Non-RE and RES at the same time
- No incentives for prosumers and to lower cost of Renewables
- Not yet a short-term/real time power market

→ **Grid and Flexibility of Power System**

- Considerable shares of inflexible power generation
- Slow grid expansion

# Scenario analysis of reducing GHG emission in power sector




GESI Green Energy Strategy Institute

→ Study by Green Energy Strategy Institute (GESI) launched in 2019

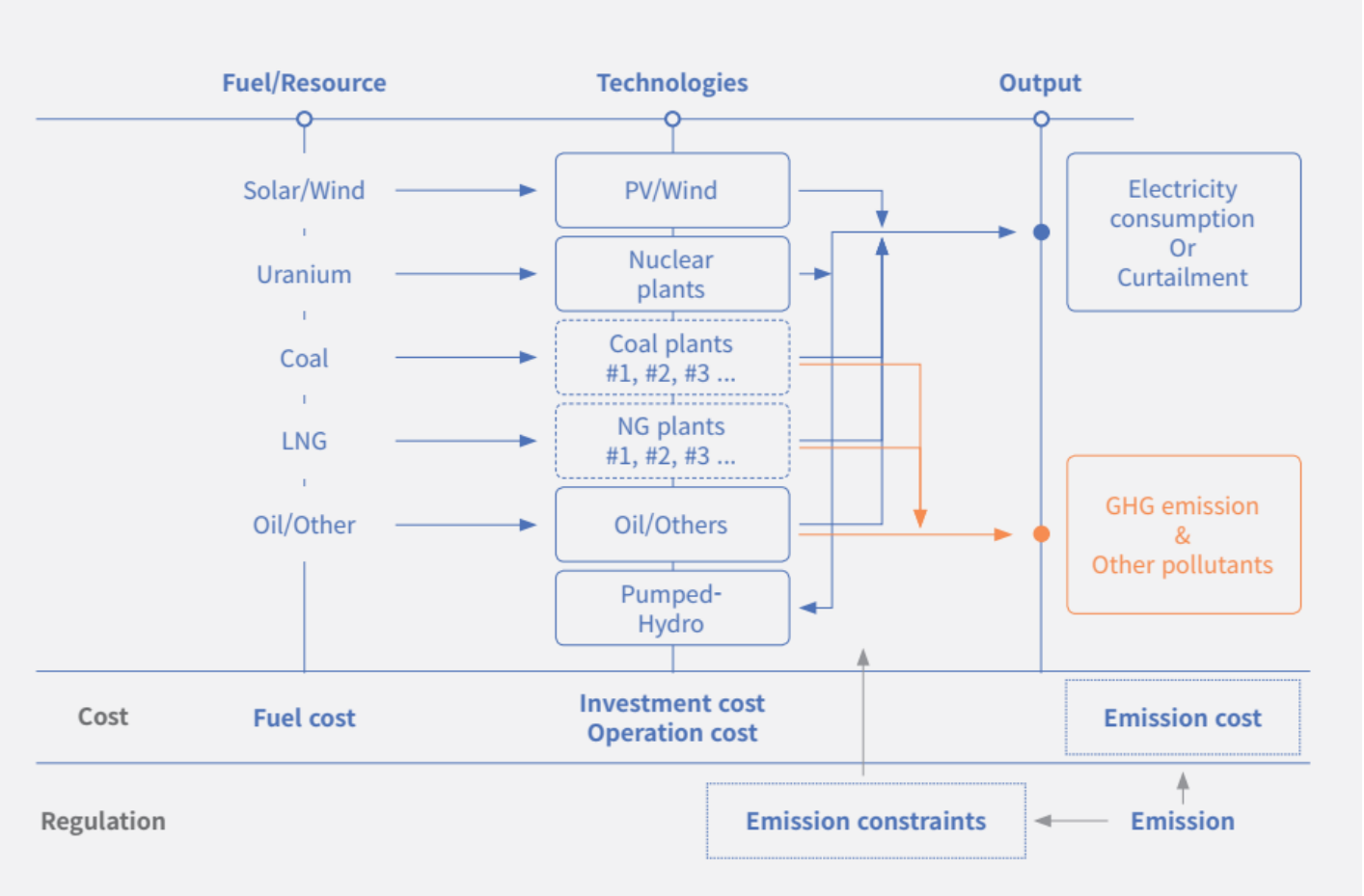
Key objectives:

→ Analyze alternative power scenarios with different $CO_2$ reduction pathways (below 150 $MtCO_2$ by 2030)

→ Investigating measures to reduce $CO_2$ emission:

- $CO_2$ pricing
- Define the schedule of phasing out coal power capacity
- Renewables expansion

# Model overview



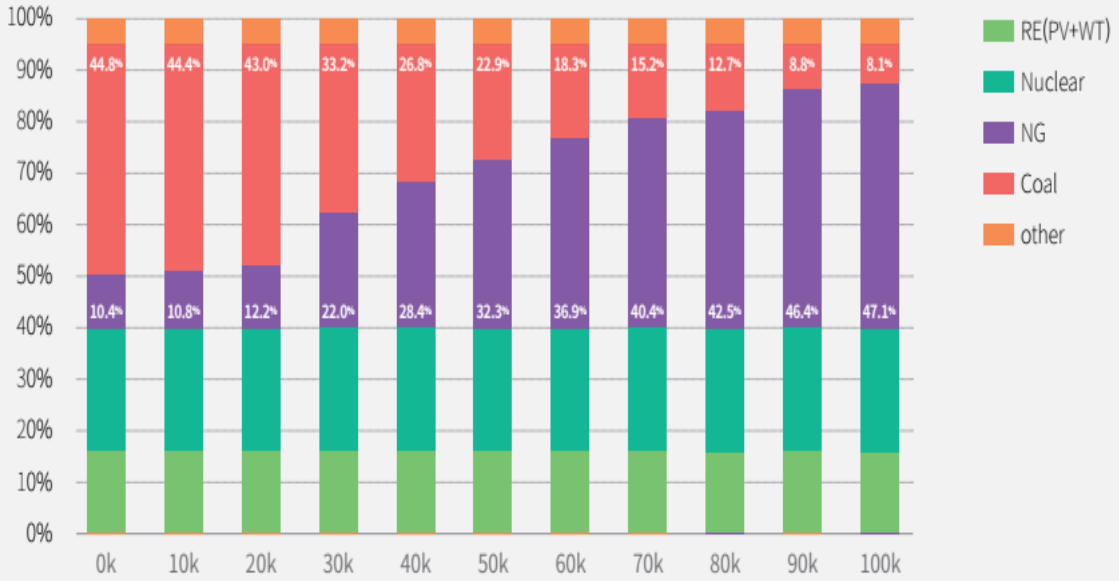

- Hourly model (8760 hours)
- Cost-optimization model
- Operational optimization
- Investment optimization for RE investment decision
- Calculate GHG emission from fuel consumption
- Calculate curtailment and regulate curtailment
- Isolated electricity system
- Pumped-hydro for energy storage

# Scenario framework

| Coal generation capacity scenario levels (4 levels) | | External cost scenario levels (8-11 levels) | | Subscenarios; RE expansion levels and Convert 7.2GW of coal plants into natural gas plants (2 levels) | |
|---|---|---|---|---|---|
| 8th | Following 8th ESDP scenario | 0k, 30k, 40k, …, 100k | 0k refers to no external cost<br>The other labels refer to emission cost levels | C | 'C' indicates scenarios of change coal plants under construction into natural gas plants(7.2GW) |
| 30yrs | Coal power plants foreclosure up to 30years | | | | |
| 25yrs | Coal power plants foreclosure up to 25years | | | R | 'R' indicates RE expansion scenarios over the 8th ESDP |
| 20yrs | Coal power plants foreclosure up to 20years | | | | |

- → $CO_2$ pricing scenarios
- → Scenarios of early retirement of coal power plants
  - Three different life spans of coal power generation: Gov. plan, 30yrs, 25yrs and 20yrs
  - 7.2GW of coal power plants under construction is assumed to be cancelled and changed into natural gas plants in order to assess the significance
- → RE expansion scenarios
  - Beyond gov. RE plan (51GW by 2030), more rapid expansion of RE is tested
  - Limiting RE expansion not to exceed a certain level of curtailment

# 1 #
# $CO_2$ pricing induced fuel switch, lower emission is reached with a high total system cost

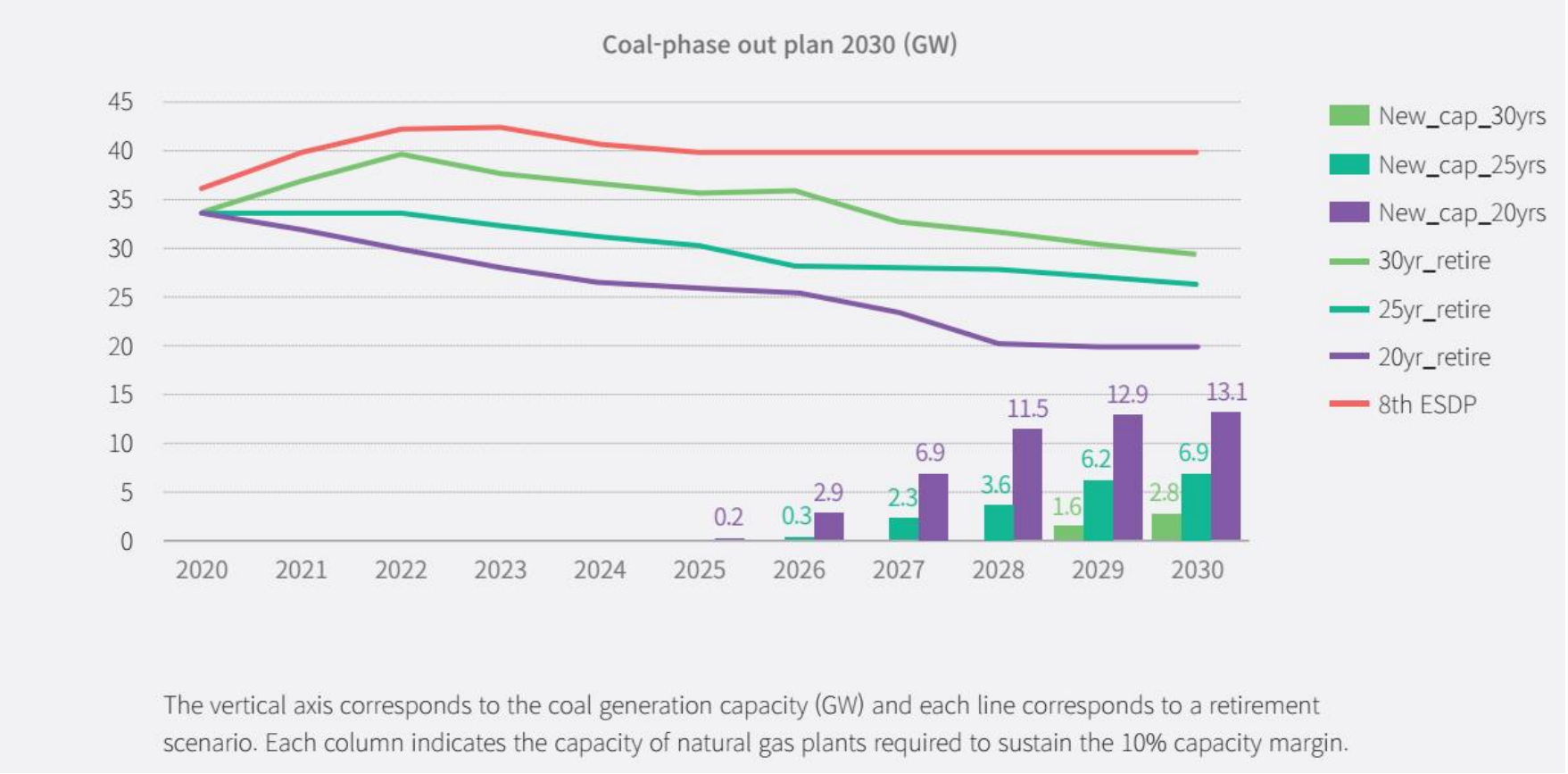




Due to internalization, highest $CO_2$ pricing has only 8% of coal, while no external cost has 45% of coal.

Natural gas power generation became cheaper than coal power generation; however, the total cost still increased significantly. Only at 100k KRW $CO_2$ pricing, the $CO_2$ emission reached 151 Mt.

# 2#
# Early retirement of coal power plant




The vertical axis corresponds to the coal generation capacity (GW) and each line corresponds to a retirement scenario. Each column indicates the capacity of natural gas plants required to sustain the 10% capacity margin.

- Assuming three different lifespans (30yrs, 25yrs, 20yrs)
- Final phase-out year would be 2052 (30yrs), 2047 (25yrs), and 2042 (20yrs)
- Without external costs, the coal generation share can be reduced to 22.5%

# Switching the 7.2 GW coal under construction accelerate the $CO_2$ reduction

- Final phase-out year would be 2046 (30yrs), 2042 (25yrs) and 2038 (20yrs)
- 7.2GW of coal power plants would cost around 10% of additional emission than other cases with the same level of external costs
- The same level of $CO_2$ emission can be achieved with lower level of $CO_2$ pricing and less stringent retirement schedule

[Table 4] Coal power plants under construction in 2019[15]

| Plant | Start date | End date | Capacity | WIP (2018) | Remark |
|---|---|---|---|---|---|
| Shin-Seocheon | 2015.11 | 2021.03 | 1GW | 55% | |
| Goseong #1 #2 | 2015.10 | 2021.10 | 2.08GW | 55% | |
| Gangreung #1 #2 | 2017.05 | 2022.06 | 2.08GW | 25.8% | Boiler ordered |
| Samchuk | 2019.07 | 2021.12<br>2022.06 | 2.1GW | 0% | Boiler ordered |

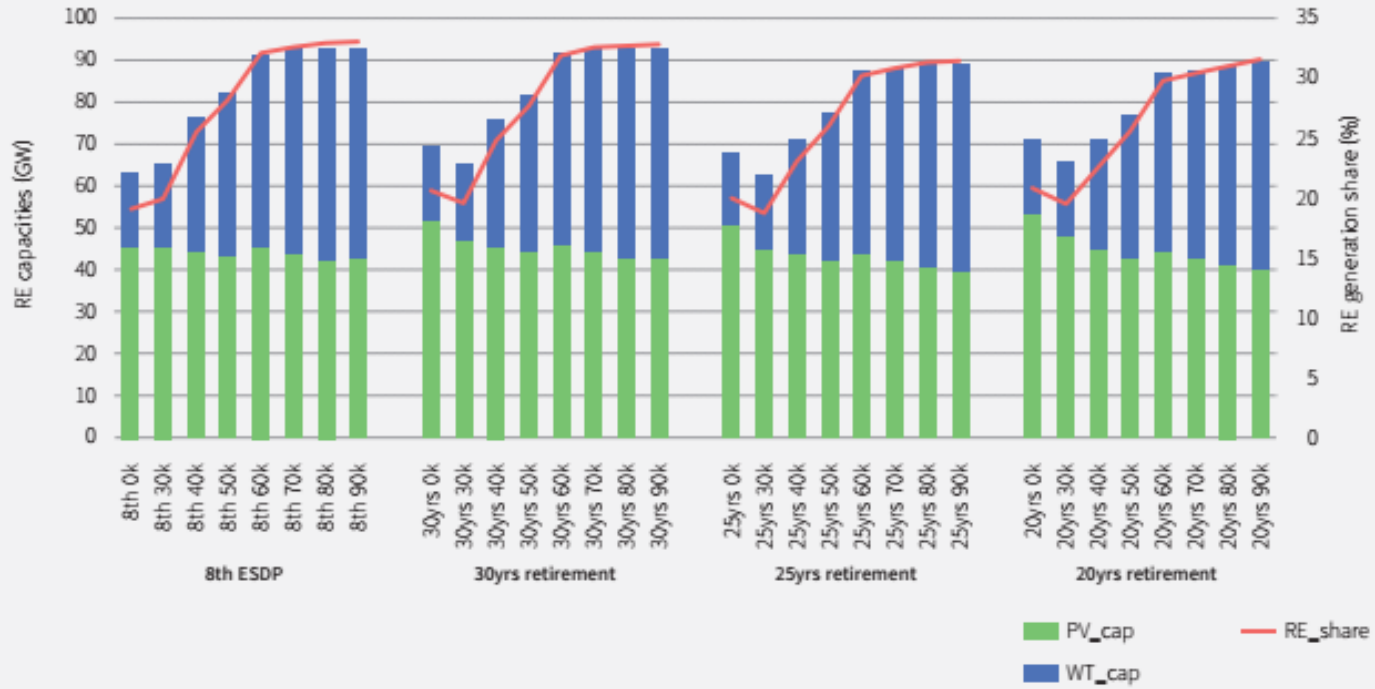
[Table 9] Comparison of scenarios wherein the coal plants currently under construction were built as planned(left) and the 7.2 GW capacity of these plants was shifted to natural gas (right)

| MCO2ton | 7.2GW coal as planned | | | | 7.2GW NG changed | | | |
|---|---|---|---|---|---|---|---|---|
| | 8th_plan | 30yrs | 25yrs | 20yrs | 8th_plan | 30yrs | 25yrs | 20yrs |
| 0k | 256.2 | 224.2 | 208.9 | 186.7 | 233.7 | 201.6 | 186.4 | 164.2 |
| 30k | 218.8 | 209.0 | 199.2 | 183.8 | 196.3 | 186.7 | 176.8 | 161.3 |
| 40k | 199.7 | 192.0 | 182.2 | 173.3 | 177.1 | 169.6 | 159.7 | 150.6 |
| 50k | 188.4 | 178.9 | 172.6 | 162.9 | 165.9 | 156.5 | 149.9 | 141.4 |
| 60k | 176.0 | 173.8 | 165.6 | 148.5 | 153.4 | 151.2 | 143.1 | 131.4 |
| 70k | 168.1 | 163.5 | 154.7 | 137.0 | 145.7 | 141.1 | 133.5 | 127.3 |
| 80k | 162.2 | 153.9 | 140.5 | 130.3 | 139.7 | 133.6 | 129.4 | 126.2 |
| 90k | 153.2 | 144.4 | 135.1 | 128.1 | 134.4 | 131.0 | 127.8 | 126.1 |
| 100k | 151.4 | 141.6 | 133.1 | 127.9 | 133.2 | 129.9 | 127.8 | 126.1 |

Comparison of scenarios wherein the coal plants currently under construction were built as planned(left) and the 7.2 GW capacity of these plants was shifted to natural gas (right). Blue shaded area refers to scenarios that met the emission target (below 150Mt CO2)

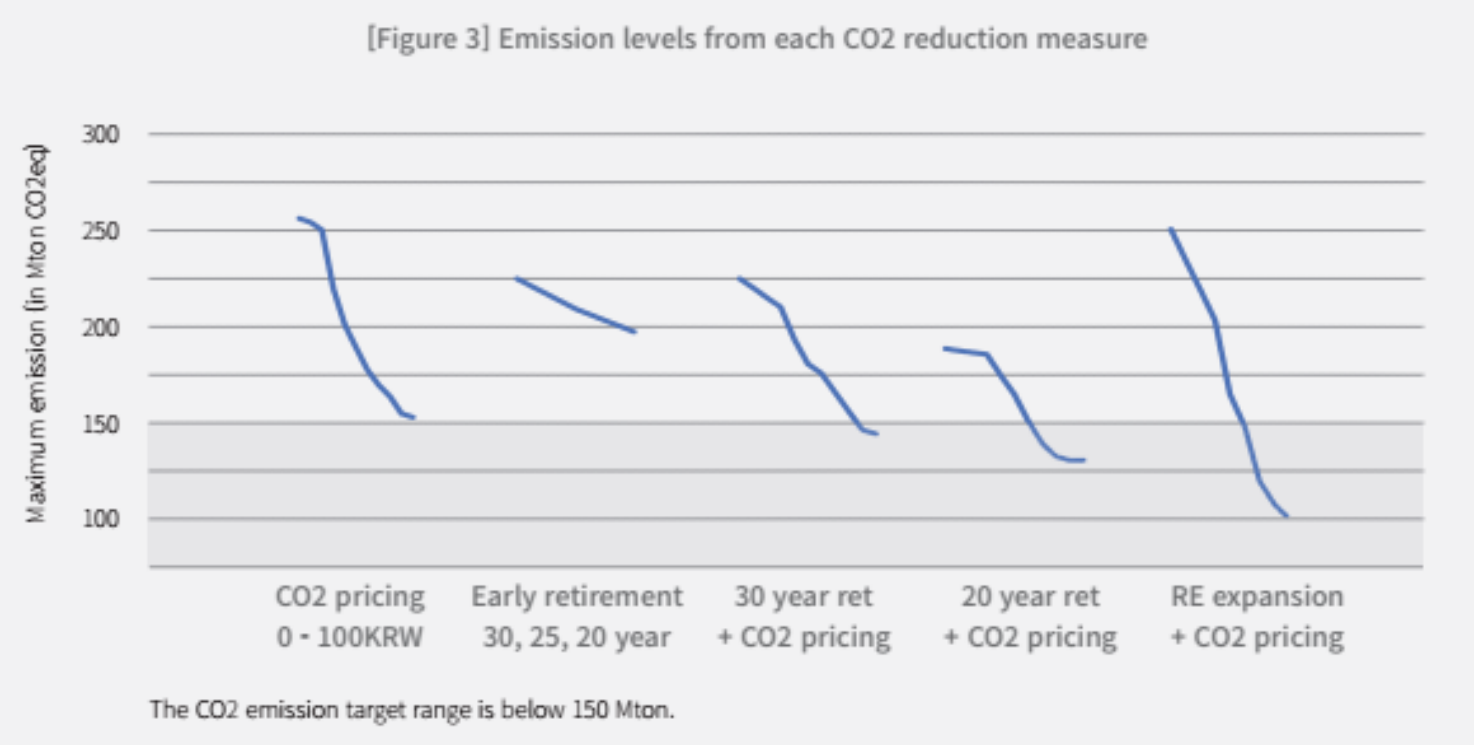
# 3#
# Increasing wind and solar share to at least 30% is a no regret measure

[Figure 21] Renewable energy capacities (PV and Wind) and RE generation share of each RE expansion scenario




- The competitiveness of RE is enhanced as more external costs are internalized by the market
- At the highest, RE capacity can be increased to 92GW (42GW of PV and 50GW of wind) and its generation share is approximately 32%
- It is more ambitious than Gov.'s plan (51GW capacity and 20% generation share)
- The addition of RE can reduce the emission to 90 $MtCO_2$ at best

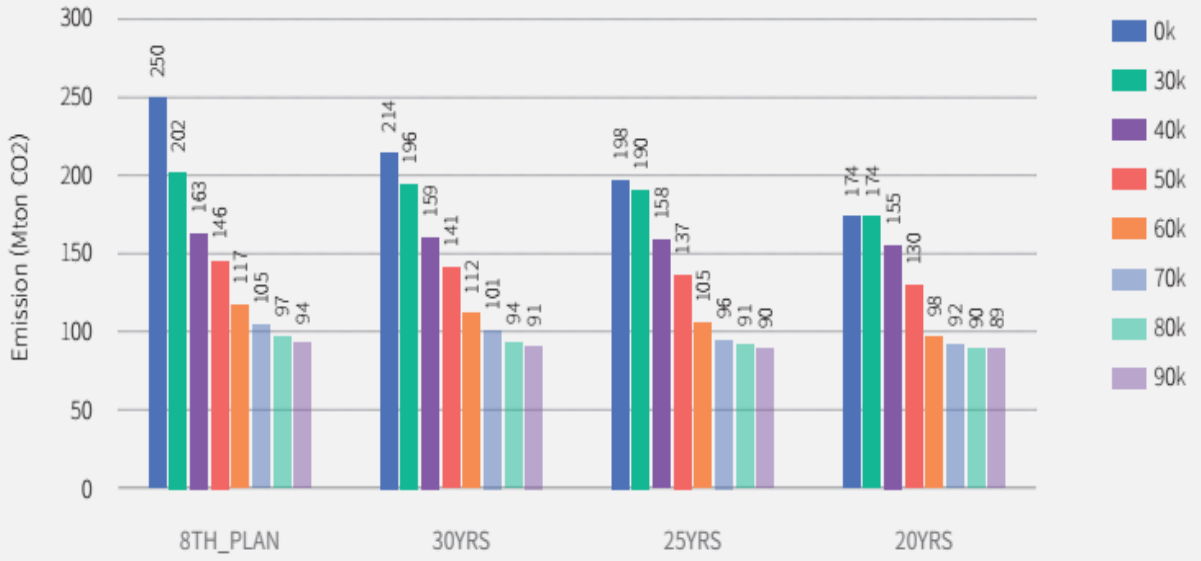
# 4#
# Individual measure ($CO_2$ pricing and early retirement) cannot achieve $CO_2$ emission target




- The emission target (150 $MtCO_2$) is more effectively achieved by a combinations of two measures ($CO_2$ pricing and early retirement of coal plants)
- Combined with more ambitious RE expansion than Gov. plan provides more feasible scenarios for the emission target
- Reaching a $CO_2$ target of 150 $MtCO_2$ can be achieved with 20% less costs with RE expansion

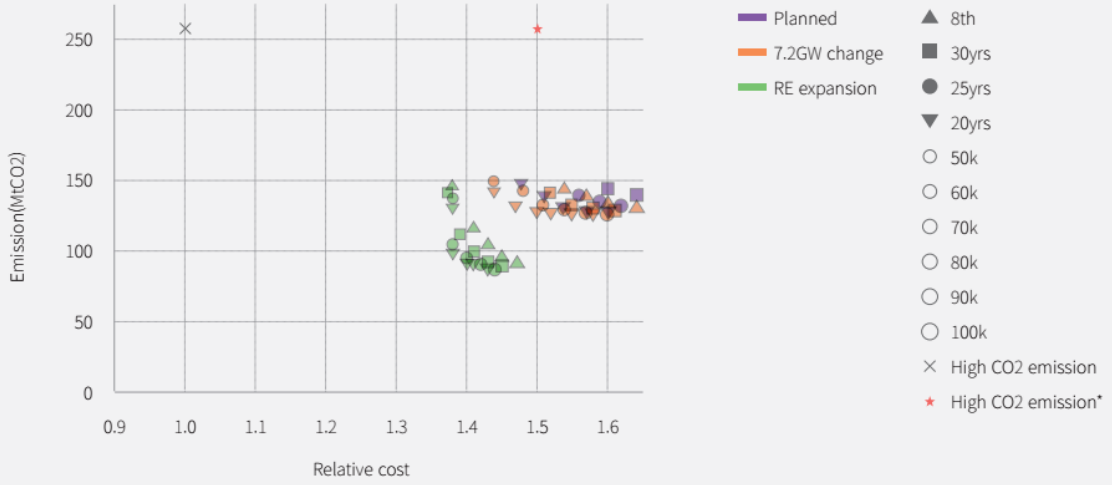
# 5#
# Renewables expansion provides a more feasible scenario reaching emission target with lower cost

[Figure 19] Emissions of each scenario with RE expansion




RE expansion reduced external costs required to reach the emission target (150 $MtCO_2$). Reduced emission with at minimum 50,000 KRW per $CO_2$ ton (40 EUR/$tCO_2$).

[Figure 4] Comparison of RE expansion scenarios and the other scenarios without RE expansion




RE expansion is an economically favorable option to reduce CO2 emission at lower cost. The "High CO2 emission*" includes the external cost of CO2 emissions (at 50 000 KRW/t) and air pollution (based on table 1), while the "High CO2 emission" does not take into account any external costs.

Reaching a $CO_2$ target of 150 $MtCO_2$ can be achieved with 20% less costs with RE expansion.

# 4 key findings and policy recommendations

| | |
|---|---|
| 1 | Reducing the $CO_2$ emissions in Korean power system by at least 40% in 2030, against current level would be required if the country aims to align itself with the existing commitments adopted by other countries. |
| 2 | Increasing renewable electricity generation target to at least 30% of power generation by 2030 is a no-regret measure to reduce $CO_2$ emissions, but for this to be fully effective it must be combined with additional policy instruments that explicitly target coal power generation. |
| 3 | Along with the effective carbon and air pollution pricing mechanisms, a coal phase-out plan defined by the Korean government is essential to reduce $CO_2$ emission at lower costs for consumer. |
| 4 | A practical and just climate policy calls for a revision of several existing climate regulations and instruments. |

# The green new deal pledges of Korean Political Parties

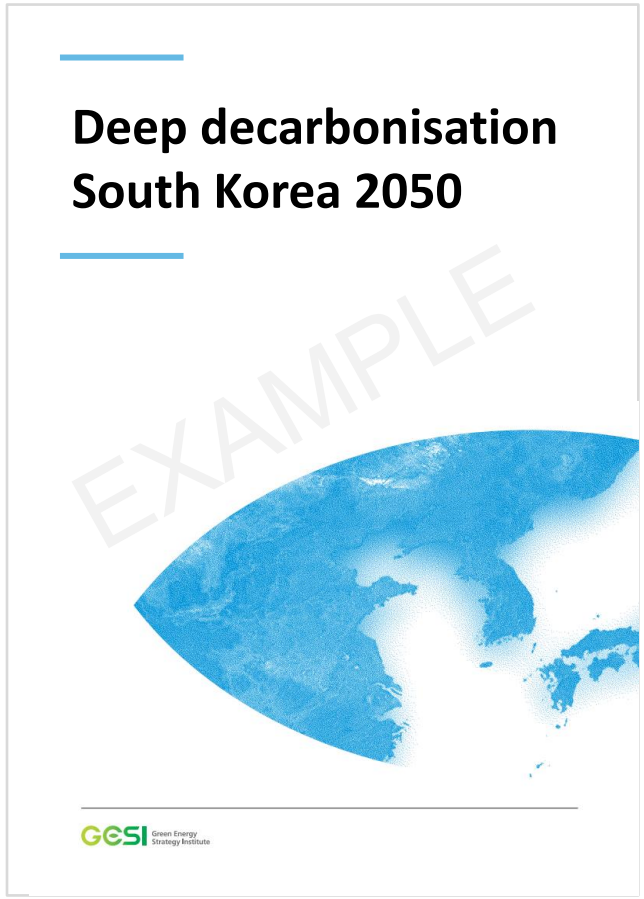
- → Minjoo Party of Korea (majority ruling party) announced the '2050 Green New Deal Vision'
- Prepared for the '2050 long-term low-carbon development strategy' and plans to enact the 'Framework act on Green New Deal'
- Discussions on the organization of members of the National Assembly to study climate change and green new deal policy (2020.04.)

**Green New Deal pledge of Korean Political Parties, 2020**

| | Minjoo Party of Korea | Justice Party | Green Party Korea |
|---|---|---|---|
| GHG mitigation target | ▪ Zero emission by 2050 | ▪ 30% emission reductions by 2030<br>▪ Zero emission by 2050 | ▪ 30% emission reductions by 2030<br>▪ Zero emission by 2050 |
| Policy | ▪ Coal Power Plant Reduction<br>▪ Renewable Energy Expansion<br>▪ Suspended 'Coal Finance'<br>▪ RE100 Market<br>▪ Expansion of electric/hydrogen vehicles<br>▪ Regional Energy Conversion Center | ▪ Phase out coal power plant until 2030<br>▪ 40% Renewable generation share(2030)<br>▪ 10 million electric vehicles(2030) | ▪ Phase out coal power plant until 2030<br>▪ 100% Renewable generation share<br>▪ Public transportation<br>▪ Green Remodeling |
| Legal and institutionalization | ▪ FRAMEWORK ACT ON Green New Deal | ▪ SPECIAL ACT ON Green New Deal<br>▪ Special Committee for Green New Deal of the National Assembly | ▪ Framework Act on Climate Crisis Response, Climate Emergency Special Committee<br>▪ Carbon Budget, Carbon impact assessment program |
| Financing | ▪ Review of carbon tax<br>▪ Expand environmental special account | ▪ Green bond<br>▪ carbon tax imposition<br>▪ Green bank | ▪ Carbon tax<br>▪ Taxes on Carbon Emission Companies |

# What‘s coming next…

- Study on deep decarbonisation South Korea 2050




- Webinar with KEIA on the green new deal

# Thank you for your attention!

Questions or Comments? Feel free to contact me:

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Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.