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Rural Transitions to Net Zero GHG Emissions in Korea

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This policy paper analyses the role of Korean rural regions in the country's transition to carbon neutrality by 2050, drawing on a conference organised by the OECD in collaboration with the Ministry of Land, Infrastructure, and Transport (MOLIT) of Korea. The report outlines the emissions profile of Korea's rural regions, compares them with other OECD countries and takes a deep dive on the three most emitting sectors: power generation, manufacturing, and transport. The paper then describes Korea's action plan to reach carbon neutrality. It discusses the just transition challenges in rural regions, highlighting employment risks and opportunities.

JEL codes: R11, R12, Q54
Keywords: Korea, climate neutrality, net zero CO2 emissions, rural regions, just transition

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Introduction

In 2019, Korean greenhouse gas (GHG) emissions ranked 9th worldwide, accounting for 1.8% of global emissions. Korea ranked 15th on GHG emissions per capita world-wide and 6th among OECD countries, with 13.6 tCO_2 equivalent per capita compared to a global average of 6.5. In its nationally determined contribution to the Paris agreement (NDC), Korea pledged to reduce its GHG emissions by 40% in 2030, compared to 2018, and to reach carbon neutrality by 2050. This pledge is enshrined in law and will require major emission reductions, which in turn will give rise to regional development and just transition challenges.[1]

There have been calls for steeper emission reductions in the near term. World-wide NDCs are insufficient to reach the goals of the Paris agreement. For example, the Climate Action Tracker argues that Korea should reduce domestic GHG emissions by 59% by 2030 to be consistent with the Paris climate agreement, even without counting in carbon sinks from land use and land use change and forestry (LULUCF) (2022[1]) which Korea includes to reach its target.

As the research for this paper has revealed, relative to other countries, Korea has particularly high per capita emissions, in particular in its rural regions, where emissions have increased in recent years. Korea's rural regions host energy-intensive manufacturing, which is difficult to decarbonise, as well as coal power generation. Achieving the rapid and large GHG reductions needed, as required to meet the Paris climate objectives, therefore requires significant overall structural transformations (ROK, 2021[2]). Moreover, across the OECD, including in Korea, rural regions tend to be vulnerable on account of their ageing population and limited economic diversification. Hence, rural regions face greater challenges in the transformation to climate neutrality. But rural regions are also part of the solution. Rural regions contain natural resources, biodiversity and ecosystem services. These will provide the bulk of the emission reduction potential through LULUCF Korea is counting on. Ecosystem services and biodiversity in rural regions can also make natural resources resilient to extreme weather events.

To shed light on these challenges and the importance of rural regions the OECD, together with Ministry of Land, Infrastructure and Transport (MOLIT) of Korea, organised a conference on Rural transitions to net zero GHG emissions in Korea in June 2022. The conference focused on the challenges and opportunities for rural regions in Korea, the action plan to reach net zero emissions in 2050, and the employment in rural regions with a focus on the just transition. The conference brought together Korean experts and policy makers from the local and regional levels of government as well as OECD staff. These proceedings provide a summary of the conference and highlight the key findings.

The first section of this policy paper provides an overview of emissions in Korean rural regions in international comparison. The second presents the Korean Action Plan to Carbon Neutrality. The third discusses some of the just transition challenges in rural regions that need to be addressed on the way to climate neutrality, highlighting employment risks and opportunities. The last section concludes with suggestions for next steps.

[1] Korea's carbon neutrality pledge is close to the net-zero greenhouse gas emission targets set by 2050 in most OECD countries. However, Korea's 2050 pledge may not include GHG beyond CO2. 9% of Korean GHG emissions in CO2 equivalents arise from GHGs other than CO2. Both the 2030 and the 2050 Korean targets may be reached with a contribution from international credits as offsets, albeit on a modest scale, as described below.

1 Korean rural regions and the transition to net zero GHG emissions

Per capita GHG emissions in Korea are relatively high, with particularly high shares of emissions from power generation and manufacturing. Emissions have overall risen in the past 10 years. This also applies to Korean rural regions, as described below. A profile of GHG emissions across all Korean regions, the sectoral contributions, as well as information on the spatial distribution of renewable energy potentials is contained in the Korea country note to the 2021 OECD Regional Outlook (OECD, 2021[3]). This paper focuses on rural regions.

According to the OECD's regional typology (Box 1.1), Korea has four small regions (TL3) classified as rural: Chungcheongnam-do, Gangwon-do, Sejong and Jeollanam-do (Figure 1.1). Unlike other OECD countries, Korea does not have any rural regions which are remote. The region of Sejong home to the city of Sejong, the new administrative capital of Korea, is an outlier it is urbanising rapidly.

Box 1.1. OECD Regional Typology

The OECD's small (TL3) regions aggregate local administrative units. They distinguish predominantly urban, intermediate, or predominantly rural (OECD, 2021[4]). Rural regions are categorised into different types according to their proximity to urban centres.

The territorial definitions of the OECD are combined to create the OECD's alternative regional typology, which introduces a notion of spatial continuity between metropolitan and non-metropolitan areas. This definition is based on the presence of Functional Urban Areas (FUAs). FUAs are composed of a 'city' and its surrounding less populated local units that are part of the city's labour markets (Dijkstra, Poelman and Veneri, 2019[5]). This accounts for daily flows of people for work, leisure and social activities, within TL3 borders and the proximity of regions to FUAs of different sizes.

Using this approach TL3 regions are classified as (OECD, 2021[4]):

- **Large metro regions** if more than 50% of its population lives in a FUA of at least 1.5 million inhabitants.
- **Metro regions** if 50% of its population live in an FUA of at least 250,000 inhabitants
- **Non metro regions close to a metro** if more than 50% of its population lives within a 60-minute drive from a metropolitan area; or if the TL3 region contains more than 80% of the area of an FUA of at least 250,000 inhabitants
- **Non metro regions close to a city** if the region does not have access to a metropolitan area and 50% of its population has access to a small or medium sized city within a 60 min drive
- **Non-metro remote regions** if 50% of its population does not have access to any FUA within a 60-minute drive.

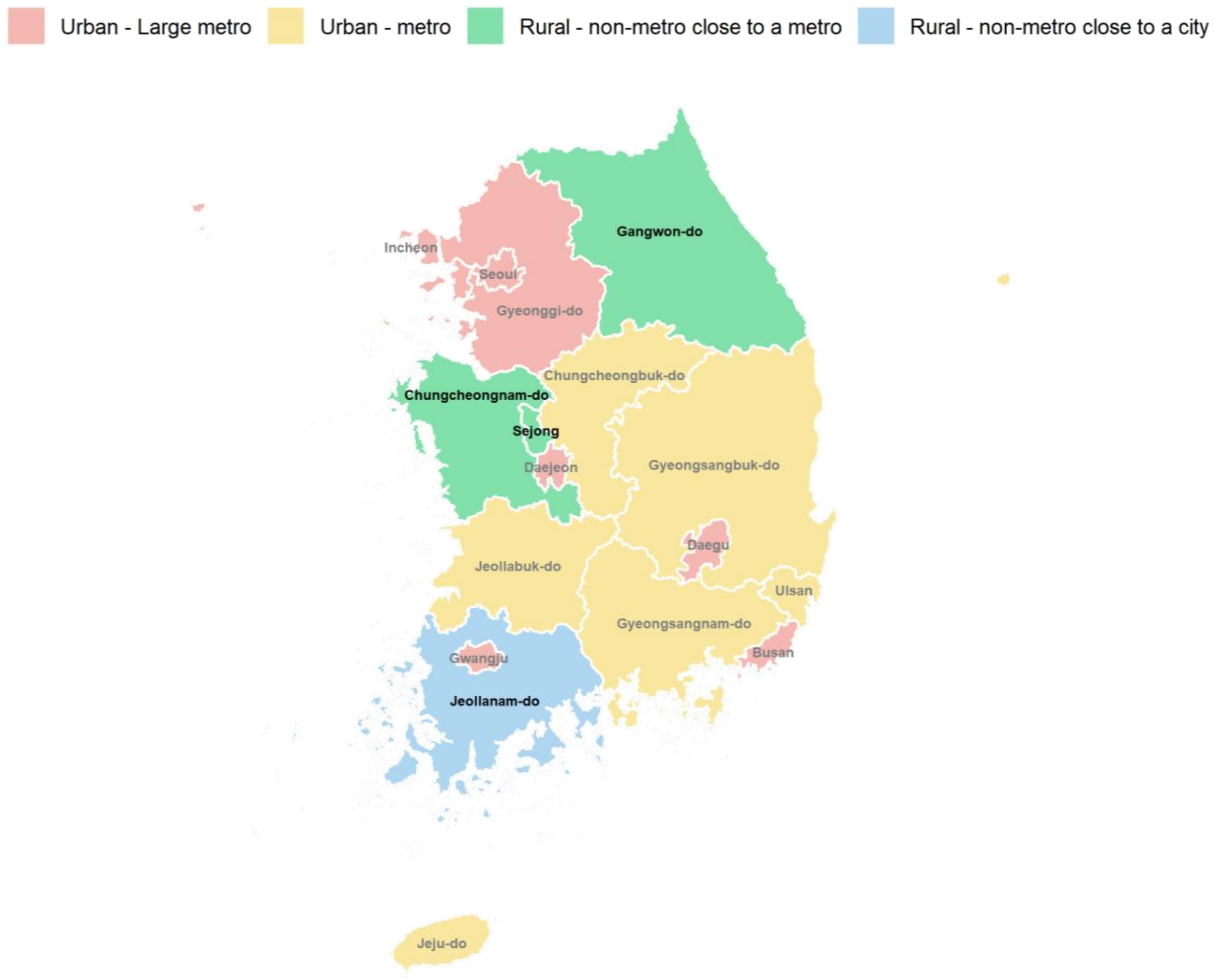
Non-metro regions are considered rural and metro regions are considered urban.

The TL3 regions in Korea are large and often heterogeneous. For instance, Jeollabuk-do, Gyeongsangnam-do, and Gyeongsangbuk-do are classified as metro regions according to the OECD classification but large areas of these regions, outside the major cities such as Gunsan, Gumi and Pohang may be considered rural. In this sense, analysing GHG emissions based on smaller geographic unites, including cities, counties and districts could be a complementary approach. Though Korea is developing a GHG emissions map based on grid cells and administrative units by 2027. TL3 regions analysed in this report allow international comparison.

Source: (OECD, 2021[4])

Figure 1.1. Korea's regions in the urban-rural spectrum

TL3 regions of Korea by OECD regional typology



Source: OECD TL3 Regional Typology (2022).

Regional rural emissions are high

Korea has the highest estimated emissions per capita (Box 1.2) in rural regions across the OECD. It is one of only a few OECD countries where rural emissions per capita grew significantly from 2010 to 2018 (Figure 1.2). However, tentative estimates of the Ministry of Environment (GIR: GHG Inventory Research centre), show that GHG emissions peaked in 2018 and declined in 2019 and 2020, in part reflecting Covid-related drops in activity (ROK, 2021[6]). Emissions bounced back in 2021, but were still below 2018 emissions. The rural regions of Chungcheongnam-do and Jeollanam-do have the largest absolute and per capita emissions in Korea.

Box 1.2. Estimating regional GHG emissions

Regional emissions are estimated based on the Emissions Database for Global Atmospheric Research (EDGAR) of the European Commission's Joint Research Centre (ECJRC). It allocates national GHG emissions from all sectors except emissions from land use, land use change and forestry, to locations according to about 300 proxies for 26 main sectors, further subdivided into subsectors, depending on the type of technology and International Energy Agency (IEA) fuel types, following IPCC reporting guidelines. Locations of emissions are identified with various sources of spatial research. The proxies capture a substantial part, but not all, of the local emission determinants.

Emissions are attributed to sectors as follows:

- **Agriculture** includes all agricultural and fishing activity, notably emissions from agricultural soils, agricultural waste burning, enteric fermentation, and manure management. Sources are attributed spatially according to agricultural land use, soil type, local livestock density, and crop type datasets and maps from the Food and Agriculture Organization (FAO). Fuel combustion emissions in the agricultural sector, while minor, are distributed over "rural" areas (mostly uninhabited and dispersed rural areas) for all fuels, except for natural gas, which is assumed to be used mainly in villages. Emissions from fuel combustion in agricultural activity are also estimated, for example, using maps of fishing activity.
- **Energy production** contains all combustion of fuels for electricity generation by power plants. Emissions are distributed according to the point source distribution data sets including intensity parameters, differentiated between fuel types (coal, gas and oil).
- **Energy extraction** includes process emissions and fugitive emissions during extraction and transportation of fossil fuels. Gas flaring activities are distributed on night-time light data for areas with strong gas flaring activities, such as the North Sea region. The coordinates of coalmines help locate related emissions and distinguishing between hard and brown coal.
- **Manufacturing** includes emissions which are allocated to the plant location coordinates on point source grid-maps. Government pollution and emission registers are the main source for point locations. A specific proxy captures cement emissions for the world-leading producers of cement based on the plant locations and annual material and energy carrier flows
- **Buildings** includes the energy use for buildings. Emissions are attributed spatially using high-resolution criteria on population and built-up density. The dataset classifies six categories of human settlements (mostly uninhabited rural, dispersed rural areas, villages, towns, suburbs, and urban centres) using satellite imagery. The data are combined with population density from updated population censuses. Emissions from fossil fuel combustion in the household and commercial sectors are attributed over total population density maps. The estimated spatial distribution of the emissions hence cannot consider subnational spatial differences in energy efficiency standards of building or fuel types.
- **Waste** includes emissions from waste incineration without energy recovery.
- **Transport** encompasses freight and passenger ground, sea, and air transport. Transport route information is used for the spatial attribution of transport emissions. Proxy data for three road types worldwide (highways, primary and secondary, residential, and commercial roads) obtained from OpenStreetMap is combined with national weighting factors to distribute emissions for each road type. The distribution depends on the type of vehicles circulating on each road type, with data on traffic flows by road type to the extent available from regional sources, or imputation of traffic flow data based on population density. Similar data is used for railways and inland waterways. For maritime traffic, traffic identification and tracking data is

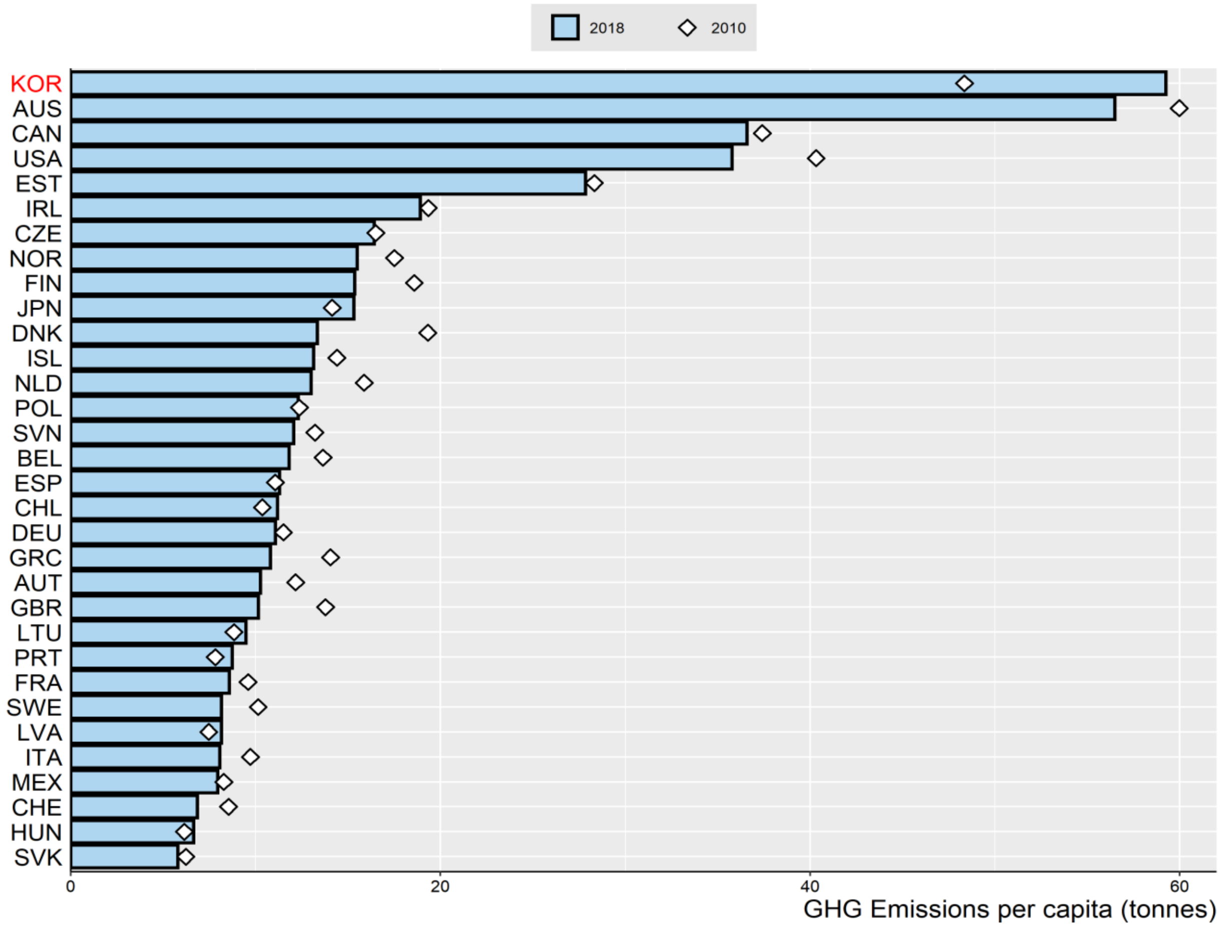
used. For air traffic, data from the International Civil Aviation Organization, flight information, and flight patterns (landing/take-off cycle) are used and allocated according to the routes.

- **Other** contains NO_x and NH_3 emissions from nitrogen deposition, using geospatial information, cropland and grassland maps and arable land. It also contains emissions from fossil fuel fires which are estimated using data on oil production and coal fires.

Note: Population-based gap-filling techniques are used for residual emissions that cannot be located, especially in the industrial and power sector.
Source: EDGAR v6 (2018), (OECD, 2021[3]).

Figure 1.2. Among OECD countries' rural regions, emissions per capita are highest in Korea

Emissions per capita of rural regions of OECD countries, in 2010 and 2018.

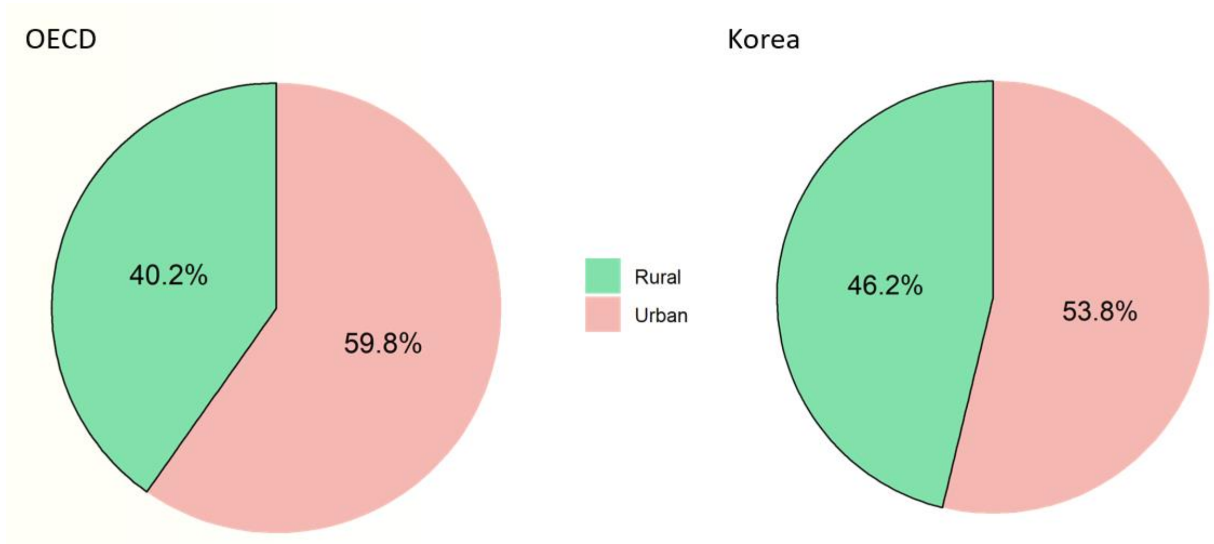


Source: OECD calculations based on European Commission (2020[7]).

Rural regions in Korea account for 46.2% percent of national emissions, above the OECD average (Figure 1.3), but account only for 11% of the Korean population. Emissions per capita in rural regions are much higher than in urban regions (Figure 1.4). Power generation accounts for the biggest share followed by manufacturing and transport. Unlike in other OECD rural regions, agriculture contributes modestly.

Figure 1.3. The share of Korean rural regions' GHG emissions is above the OECD average

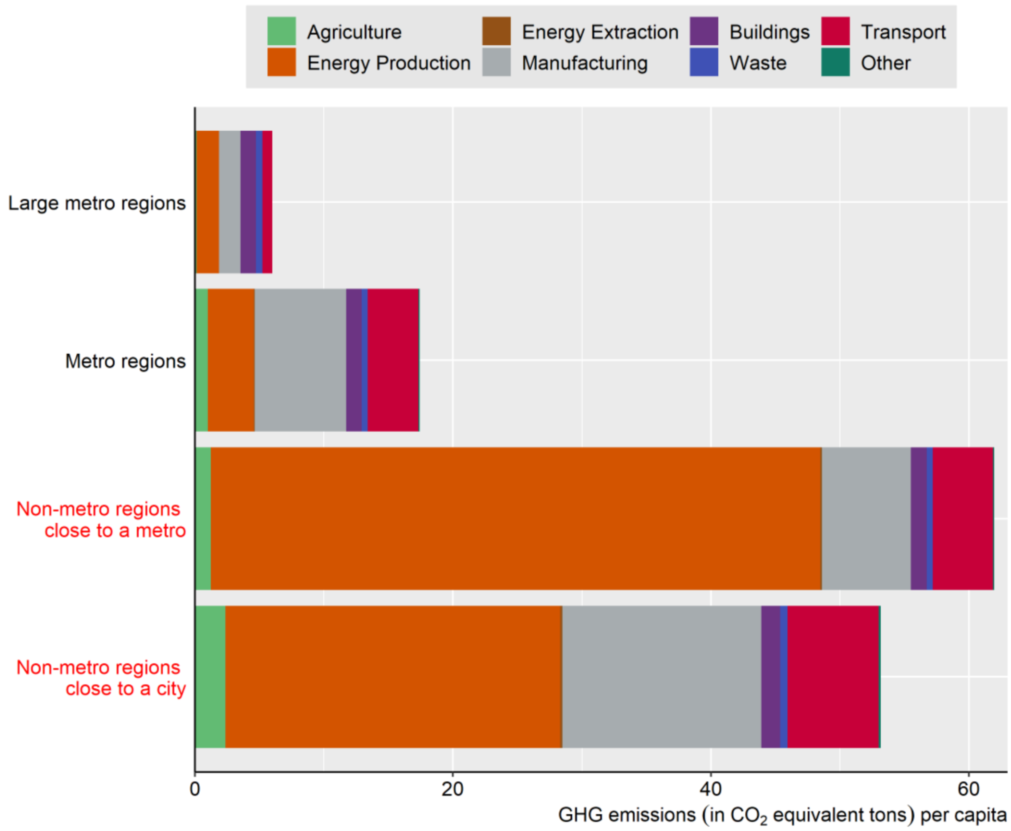
Share of rural and urban GHG emissions in the OECD and in Korea.



Source: OECD calculations based on European Commission (2020[7]).

Figure 1.4. Emissions per capita are much higher in rural than in urban regions in Korea

Emissions per capita in Korean regions, by type of region (OECD classification) and by sector, 2018



Source: OECD calculations based on European Commission (2020[7]).

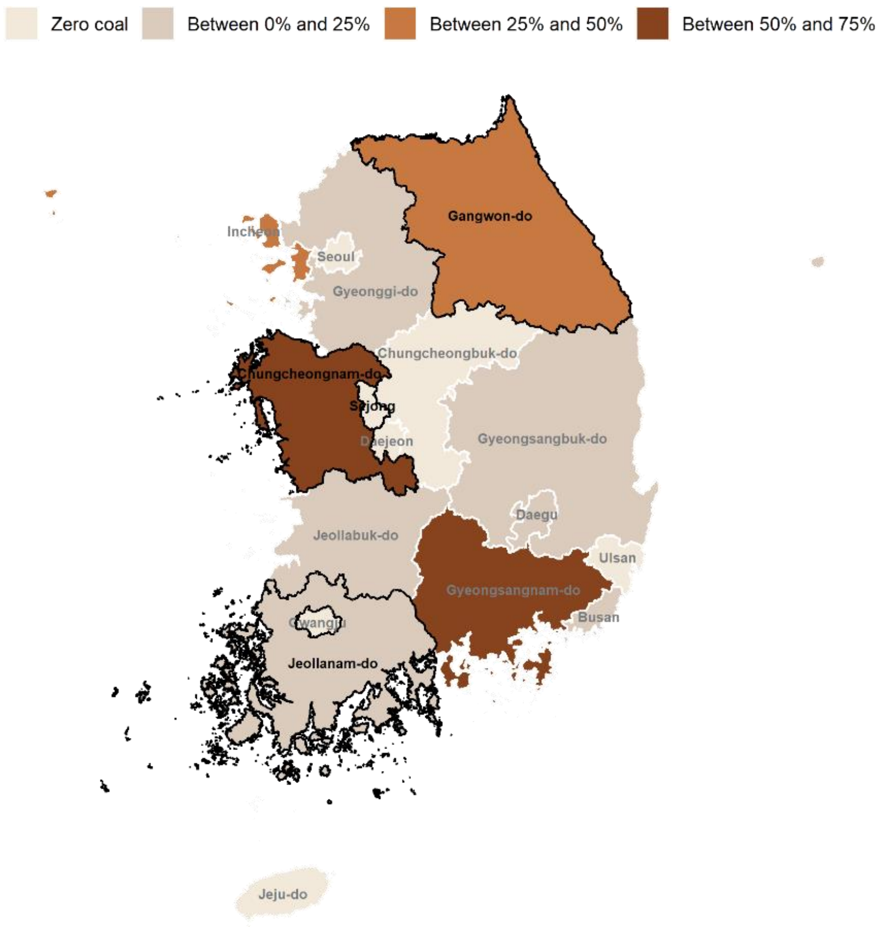
High per capita emissions in Korea's rural regions have regional development implications. The rural population may face bigger transition challenges than the metropolitan population.

Power generation contributes the most to emissions

In 2022, the power generation sector accounted for 47% of GHG emissions in rural regions. Most stem from coal-fired power. In Korea, most coal power plants are in the rural regions of Chungcheongnam-do and Gangwon-do. Chungcheongnam-do generates 70% and Gangwon-do 47% of their electricity generation from coal (Figure 1.5). The rural region of Sejong hosts no coal-fired power but relies on liquefied natural gas (LNG) for almost 90% of electricity generation.

Figure 1.5. Chungcheongnam-do relies heavily on coal for electricity generation

Share of coal in electricity generation in Korean TL3 regions, 2022



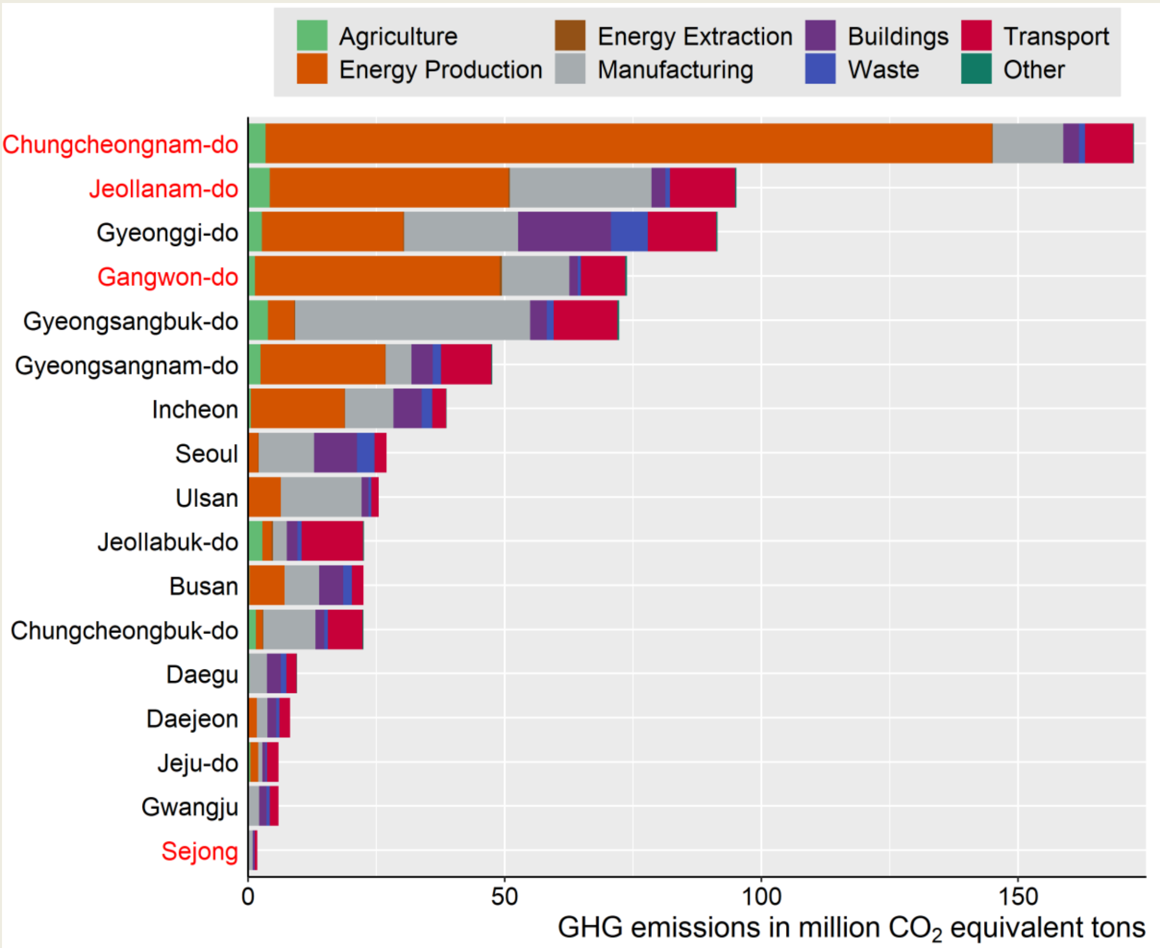
Source: Korean Statistics (2022).

Box 1.3. Coal Generation in Chungcheongnam-do

Chungcheongnam-do covers 8.2% of Korea's land and has a population of 2.12 million people. Chungcheongnam-do's gross regional domestic product (GRDP) is the fourth largest in Korea. Chungcheongnam-do is the highest-emitting region accounting for almost a quarter of national emissions (Figure 1.6). The power generation sector overwhelmingly contributes. Out of Korea's 57 coal power plants, 29 are in Chungcheongnam-do (Figure 1.7). Chungcheongnam-do's share of national coal power generation is 48% with the installed capacity of 18,000 MW and generation volume of 96 million MWh.

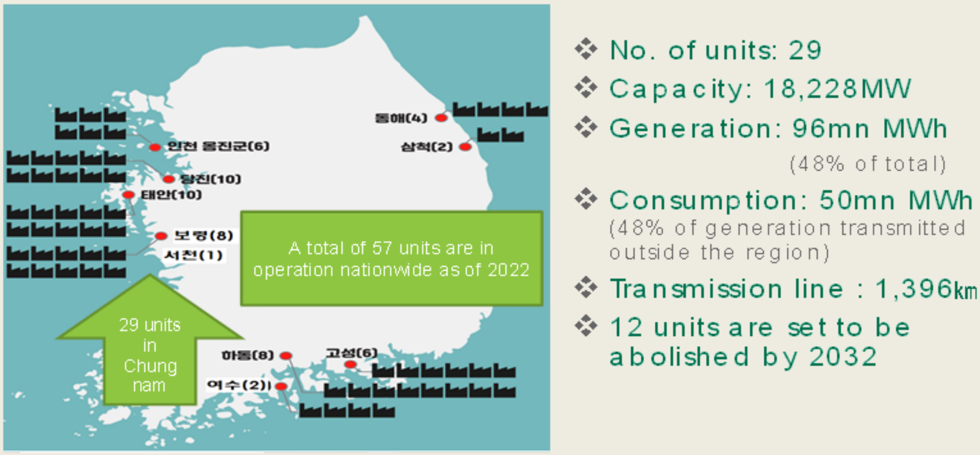
Figure 1.6. Chungcheongnam-do is the highest-emitting region in Korea due to power generation

2018



Note: Names of rural regions are in red.
Source: OECD calculations based on European Commission (2020[7]).

Figure 1.7. About half of the coal power plants in Korea are concentrated in Chungcheongnam-do.



Source: Presentation of Chungcheongnam-do, Net-zero conference (2022. 6)

In December 2021, Chungnam province announced an ambitious scenario aimed at achieving carbon neutrality in 2045, five years ahead of the national goal. The scenario plans to reduce GHG emissions by 50% from the 2018 level by 2035 and to achieve carbon neutrality within another 10 years based on reduction measures for each sector (e.g., electricity generation, industry, buildings, transportation, etc.).

Source: Presentation of Chungcheongnam-do, Net-zero conference (2022. 6)

According to the International Energy Agency (IEA) Sustainable Development Scenario (SDS), a Paris-consistent emission reduction scenario that includes established net-zero emission targets, coal needs to be mostly phased out by 2030 world-wide, and gas generation by 2050 (IEA, 2021[8]). High-income countries may need to be more ambitious. According to the Powering Past Coal Alliance, for Korea to be compatible with the Paris climate agreement, unabated coal needs to be completely phased out by 2030 (Power Past Coal Alliance, 2021[9]). Electrification is the basis for the decarbonisation of other sectors. For this reason power generation should be decarbonised early. Coal is particularly emissions-intensive so its use in power generation needs to be phased out first.

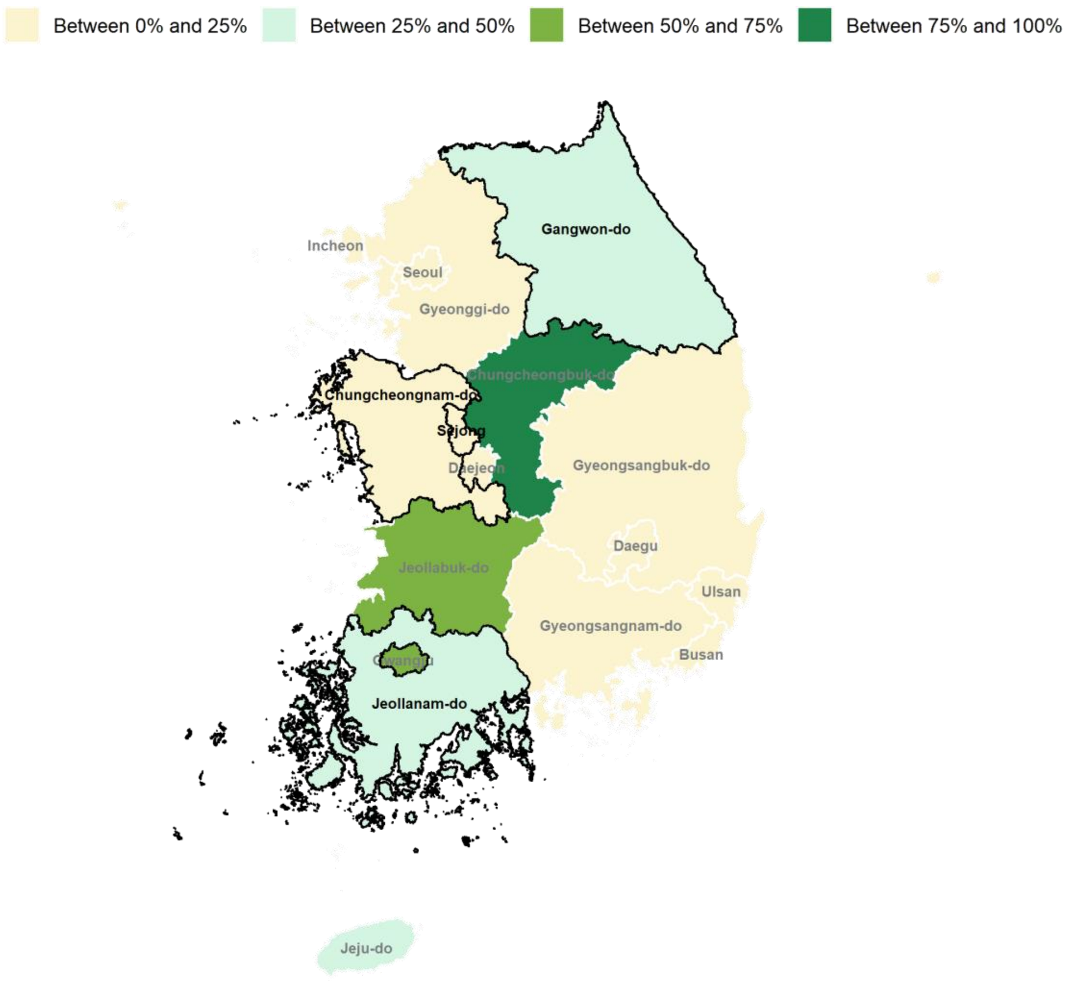
Korea's government plans to phase out 30 coal power plants by 2034, converting 24 of them to LNG. However, 27 coal power plants may remain open in 2034. Indeed, according to the 9th basic plan on Electricity Demand and Supply, there are coal power plants under construction in Gangwon-do (MTIE, 2020[10]), that will be operational by 2024. Further investment in fossil fuel plants generates the risk of stranded assets, as achieving the Paris Agreement climate ambitions, will mean that the plants will not be used for the whole lifecycle.

Phasing out coal and other fossil fuels brings well-being benefits beyond climate benefits (OECD, 2019[11]). Renewable electricity is cheaper to produce and avoids water and soil pollution from coal-fired power. In 2021, the global average levelised cost of electricity (LCOE) of solar PV and wind power was 11% and 39% (respectively) cheaper than the cheapest fossil fuel-fired powered generation (IRENA, 2022[12]). In addition, phasing out coal-power would reduce local outdoor air pollution, which is responsible for premature deaths, illness and loss of cognitive capacity, with particularly severe impacts on children (OECD, 2021[3]). It would also reduce negative effects along the whole value chain of fossil fuel production, such as biodiversity damage, water and soil pollution from coal mining, though these would mostly occur abroad. Since Korea imports most of its coal, moving away from coal will increase the country's energy security. In the absence of substantial employment in coal mining the employment effects will be relatively small.

In OECD countries on average, 27% of electricity generation arises from renewable sources. The Korean rural regions of Sejong (10%), Chungcheongnam-do (11%) and Gangwon-do (25%) generate a smaller share of energy from renewable sources than the OECD average (Figure 1.8). Jeollanam-do generates 35% of its energy from renewable sources.

Figure 1.8. Rural regions in Korea generate little power from renewables

Share of renewable electricity generation in Korean TL3 regions, 2022



Note: Renewable generation includes hydropower, solar, wind, biofuels, waste, tide, geothermal, marine and concentrated solar power (CSP).
Source: Korean Statistics (2022)

Korea is striving to promote renewable energy sources nationwide. The previous administration launched a "Renewable Energy 3020" plan in 2017, aiming to increase the renewable electricity share to 20% by 2030. Installed renewable power capacity in Korea has grown at an annual average of 28% since 2017.

According to the IEA, the renewable electricity generation share should reach 61% by 2030 to achieve the net-zero emissions by 2050 (IEA, 2021[8]).

Across OECD countries, renewable electricity generation is particularly strong in rural regions, where the potential for wind and solar electricity generation is high and more land is available (OECD, 2021[3]). Korea faces some challenges in this regard as economically feasible sites are limited due to low-capacity utilisation of renewable facilities and geographical reasons, such as a high proportion of mountainous areas. Even so, wind and solar power are widely recognised to be among the lowest-cost sources of electricity generation in Korea.

Making the most of renewable energy potential in rural areas requires the support of local populations through appropriate governance. The participation of local populations in the profits of renewable electricity production and in the decision-making of placement of installations can help expand uptake of renewables. (OECD, 2021[3]).Social resistance often occurs due to the lack of systematic and consistent communication with the residents (Lee, Lee and Lee, 2019[13]). The fear of negative impacts such as low-frequency noise of the wind turbines and risk of landslide around solar energy installations has risen among local people. To enhance residents' acceptance, the Korean government is promoting policies to encourage the investment of residents in renewable energy projects, while providing proper information through diverse channels. The German region of North Rhine-Westphalia set up wind energy dialogues and mediation on renewable energy projects at the local level to overcome concerns of the effect of turbines on the people, wildlife and scenery. This includes expert advice, round table discussions as well as mediation with municipalities to help negotiate positions, ideas and interests. (OECD, 2021[3]).

Another challenge lies in integrating variable renewable energy (VRE) sources, which naturally fluctuate, notably wind and solar, into the electricity grid and maintaining its stability. As the proportion of VRE sources increases, the system costs of grid operation increases. In Jeju, for example, where nearly 20% of total power comes from VRE, curtailments in the generation of renewable electricity due to oversupply have become frequent. In 2021, the wind power generation industry in Jeju experienced 64 curtailments sustaining losses amounting to USD 2.4 million, along with the first curtailment for solar power. The curtailment share in wind power generation reached 3.24% in 2020 and is predicted to increase to 11.6% in 2030 if VRE investment continues as planned. Since losses due to the curtailment are not compensated, this risk discourages the private sector from further investing in renewable energy. Investment in transmission and distribution grids, expanding storage or conversion facilities (e.g., ESS (Energy Storage System), P2G (Power to Gas), P2H (Power to Heat), etc.) co-ordinated with the adjustment of power demand through flexible pricing over time and space, based on accurate renewable energy generation output prediction, can reduce system costs sharply. They offer economic opportunities from using low-cost renewable energy when it is abundant, for example, through the smart charging of electric vehicles.

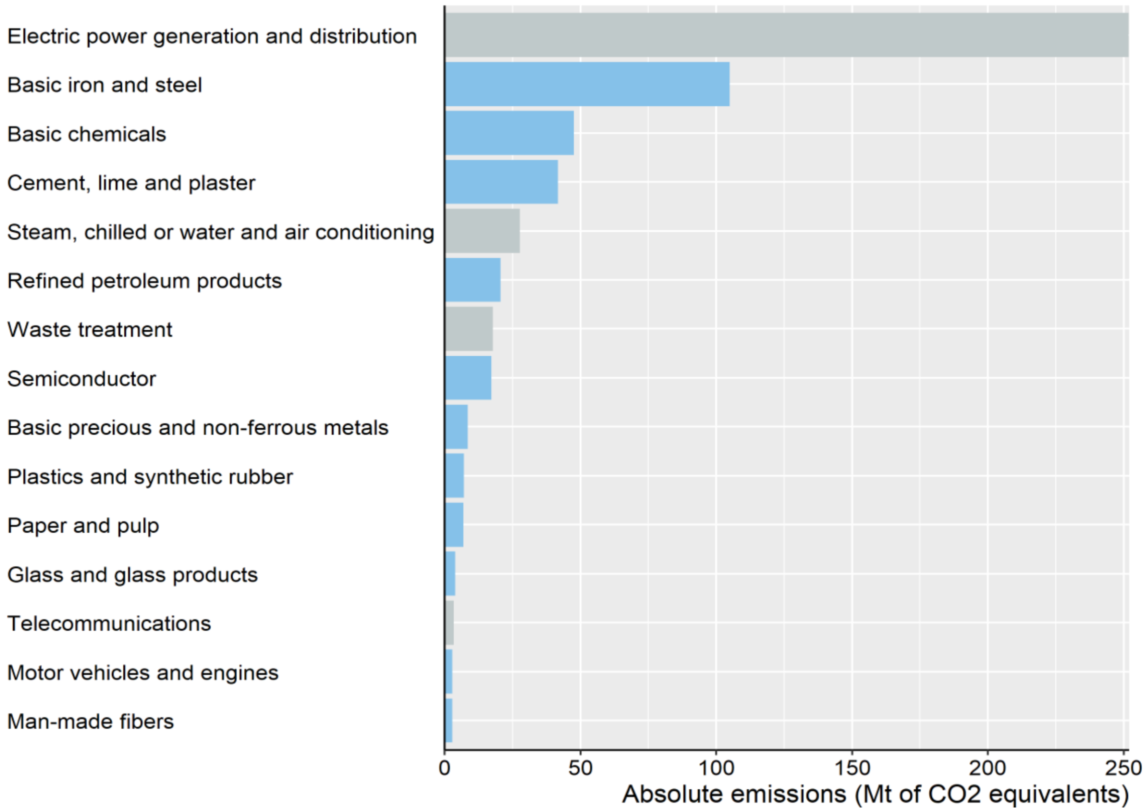
The manufacturing sector will face large transformations in rural regions

The manufacturing and construction sectors combined accounted for about 16.1% of rural regions GHG emissions in 2018. As of 2018, energy consumption-related emissions accounted for 78.4% of manufacturing emissions and process emissions for 21.6% (ROK, 2021[2]).

Some manufacturing sectors face particularly large transformations in the transition to carbon neutrality, with important regional development implications. These sectors include chemicals, steel, cement, refined oil and petroleum products as well as paper and pulp. They are particularly emission and energy intensive. In addition, vehicles manufacturing is an important employer and will need to shift from internal combustion to electric motors.

These six sectors require new production technologies to reach carbon neutrality, new infrastructure to provide zero-emission energy and, in some cases, different, zero-emission consistent raw materials. They will also require moving to circular economy practices to reduce energy and material consumption substantially (OECD, 2023[14]). Data from the Korean Emissions Trading Scheme (ETS) indicate that manufacturing emissions are concentrated in the sectors that will face large transformations (Figure 1.9), with important contributions to national emissions (689Mt CO2 equivalent in 2018). For example, basic iron and steel production contributes close to 15% to national GHG emissions. These emissions data are so far not available on a regional scale. Regional emissions data would allow to assess which regions need to address sector-specific major transformation challenges and their regional development implications. The Korean ETS also includes power generation as well as indirect emissions in heating and cooling from electricity use.

Figure 1.9. The manufacturing sectors combined make up a big share of Korean ETS emissions, 2018



Source: Korea ETS (2018).

Some manufacturing sectors require very high temperatures in their production processes which are difficult to reach with electric heat. In some of them, notably cement, production processes are particularly difficult to make climate neutral. Hence, alternative decarbonisation technologies are necessary such as hydrogen and carbon capture and storage (CCS). Hydrogen can replace coal or other fossil fuels in primary steel and chemicals production. Cement production is likely to be most dependent on CCS to become climate neutral (OECD, 2023[14]). New infrastructure is therefore necessary to transport and store hydrogen, as well as to develop CCS. Pipelines are the most suitable onshore transport mode for hydrogen and CCS. Infrastructure for hydrogen and CCS is subject to scale economies. Hence, regions with industry clusters can share infrastructure costs. Natural gas pipelines can be repurposed to transport hydrogen at a low cost. CCS is more likely to require new pipelines (OECD, 2023[14]).

Emission-free “green” hydrogen production requires emission-free electricity. Hydrogen production costs critically depend on renewable energy potential, notably from onshore wind or solar. The potential for wind and solar power are highest in the Middle Eastern and African countries. The cost of imported hydrogen also depends on soft factors such as government support, and political stability. Australia, Chile, Morocco, and Spain stand out as countries with the greatest potential to emerge as net hydrogen exporting nations (IRENA, 2022[15]). Importing green hydrogen from these countries will be particularly economically attractive (Hydrogeninsight, 2023[16]). In Korea hydrogen will thus be largely imported through ports, hence regions with access to ports may have an advantage. Korea plans to expand use of emission-free “green” hydrogen, and expand related R&D.

Decarbonizing the manufacturing sector brings about well-being benefits beyond climate (OECD, 2019[11]). In addition to health benefits from reduced pollution, decarbonization reduces the dependence on raw materials, as manufacturing moves towards a circular economy, which can make manufacturing more resilient to foreign shocks. Raw materials processing is associated to large global environmental damage, including biodiversity loss, land degradation and climate change (OECD, 2019[17]). Moving to a circular economy in manufacturing can also reduce energy consumption substantially, a key to keeping costs of the transition to carbon neutrality low.

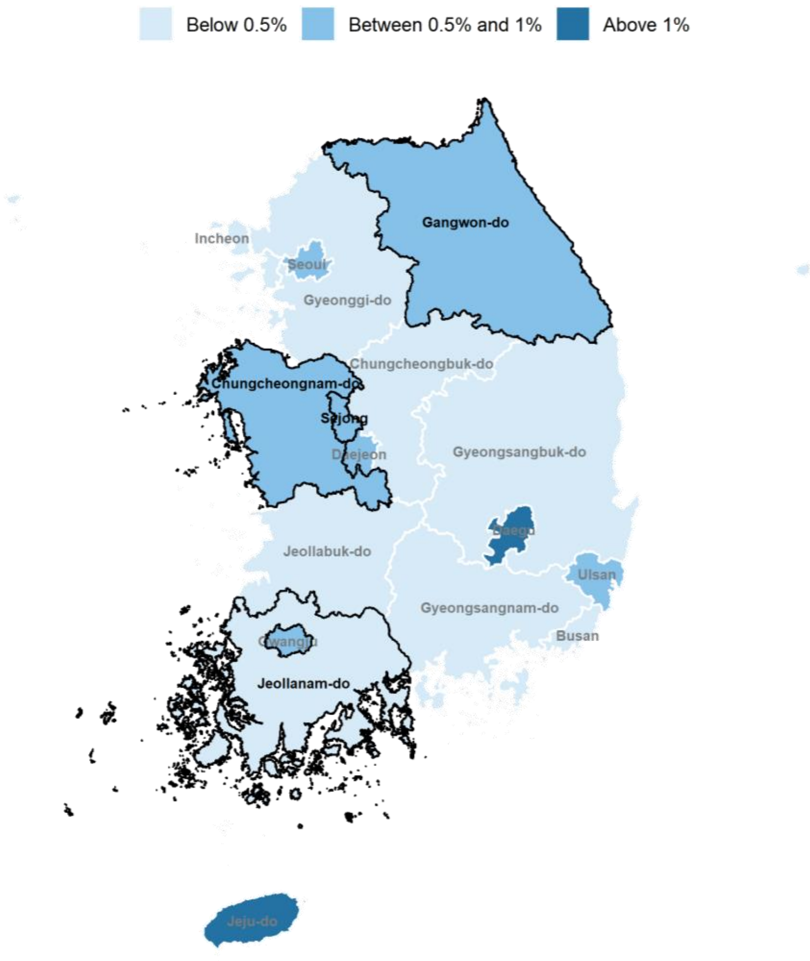
Transport in rural regions needs to be decarbonized

Transport in rural regions contributes 9% to GHG emissions. The decarbonisation of transport requires a broad strategy, including reduced use of private cars and the use of lighter cars (OECD, 2021[3]). Such a broad strategy would contribute to reducing energy consumption and limit the environmental footprint of electric car production. The potential for reducing car use is biggest in urban areas.

Passenger transport in rural regions is highly dependent on private vehicles and the share of zero-emissions vehicles (ZEVs) is still low. Korean rural regions all have a share of ZEVs below 0.7% (Figure 1.10). In Norway some regions reach a share of 10%. However, in most OECD regions the share of ZEVs is still below 1% (OECD, 2021[3]). A cost-effective date for all sales of new passenger cars to be ZEVs from the users’ point of view may be 2030 or no later than 2035 globally (The UK Climate Change Comittee, 2020[18]). This benchmark includes stopping sales of new internal combustion and hybrid vehicles. According to the IEA’s Sustainable development scenario (SDS), OECD countries should fully phase out conventional car sales by 2040 (IEA, 2020[19]).

Figure 1.10. ZEV ownership remain low in Korea

Share of ZEV ownership in Korean TL3 regions, 2020



Source: Korea Statistics (2020).

Currently electric vehicles are still more expensive to purchase than conventional cars. However, the cost of current use, from fuel consumption and maintenance is already lower than for conventional cars. Light-weight electric vehicles may therefore be particularly attractive in rural regions because rural residents travel longer distances. A break-even point between ZEVs and internal combustion engines may be reached in 2023 (OECD, 2021[3]). Moreover, cost projections suggest electric vehicles will become cheaper to produce and purchase around 2027. However, most electric vehicles have a range of less than 500km, so it will be essential to be strategic and targeted in the location of charging infrastructure, given the financial challenges of providing access in thinly populated rural regions. Korea is one of the leading countries in terms of charging infrastructure as highlighted in the IEA Global Electric Vehicle Outlook 2022, with rapidly expansion. According to the ministry of Environment, there are 194,081 chargers (fast 20,641 / slow 173,440) as of Dec 2022. Appropriate land use planning can also make public transport, walking and cycling (notably with electric bikes) more viable for rural regions.

The decarbonisation of freight, especially road freight, is also important, but progress is slower. No unique technology for decarbonising road freight has yet emerged. It could for example rely on synthetic fuels produced with green hydrogen or electric systems integrated in road infrastructure. However, battery electric vehicles may be the lowest-cost options in many cases. A carbon neutral road freight sector needs to meet the needs of the manufacturing sector. For freight transport, infrastructure is also essential for the transition to ensure charging, fuelling or electricity supply. Deployment of such infrastructure is a near-term priority to move road freight towards net-zero emissions. Freight transport is particularly important for manufacturing sectors producing essential materials and goods, such as iron and steel (OECD, 2023[14]). Transport cost are an important consideration in these industries. Transport costs may rise more strongly in the context of decarbonisation in regions where rail infrastructure is not available.

2 Korea's Action Plan to Carbon Neutrality

Plans are being developed to translate the mid-to long-term overall greenhouse gas emission reduction targets to sectoral goals, as well as to lay the basis for actions to reach them, including specific systems such as the Korean Emissions Trading System (K-ETS) and the GHG & Energy Target Management System (TMS).

Box 2.1. Korea's Target Management System (TMS) for GHG emissions reduction

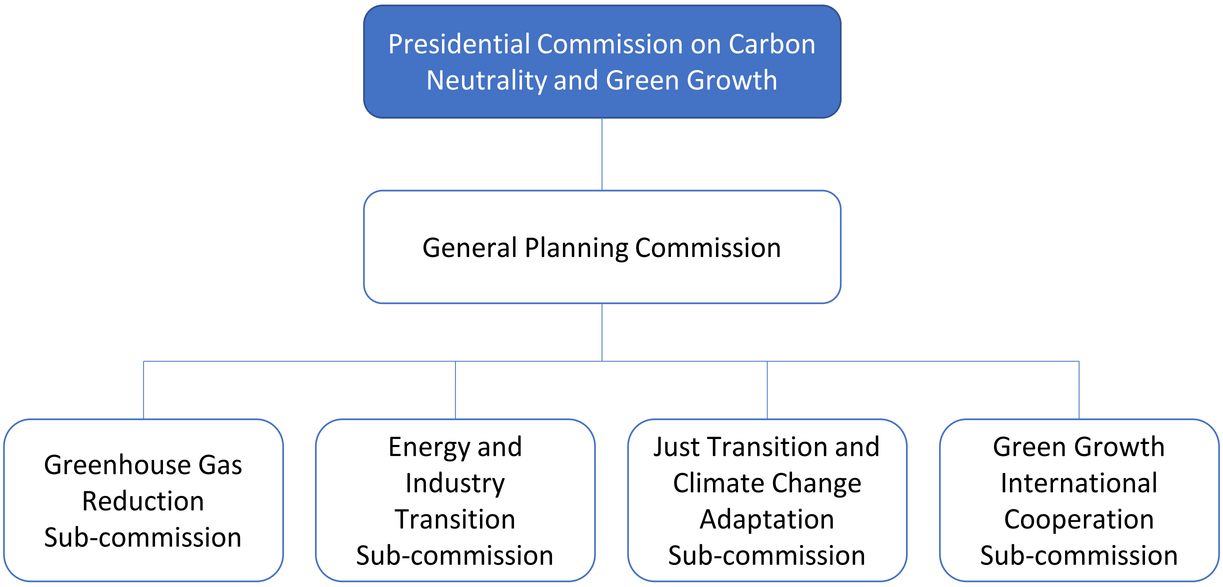
Korea's Target Management System started in 2010 according to the Carbon Neutrality Framework Act. Entities whose average annual GHG emissions of the past three years are above 50,000 tCO_2eq, and business sites whose emissions are above 15,000 tCO_2eq should set emission reductions targets and achieve them. If not, they are regulated in the form of an improvement order or a fine. 360 companies are regulated by TMS, as of June 2022.

Source: Korea Environment Corporation (https://www.keco.or.kr/en/core/climate_supporting1/contentsid/1934/index.do)

At the same time, various other policies are being developed: the Renewable Portfolio Standard (RPS) aims to increase the share of renewable energy and promote the energy transition. The Zero-energy Building Certification and Energy Efficiency Resource Standards (EERS) were introduced in the buildings and the industry sector in 2016 and 2018, respectively. Policies to increase the supply of eco-friendly vehicles (e.g., hybrid, low-emission, zero-emission) and to improve the public transport system are being developed (ROK, 2021[6]).

Korea created the 2050 Carbon Neutrality Commission in May 2021 as an executive body to facilitate the transition to a carbon neutral society by 2050 in all areas of industry, economy and society. The organisation serves as a "control tower" of Korea's carbon neutrality policies and reports to the President. Eight joint private sector-government committees (Figure 2.1) that each consist of 18 leaders from central government agencies, industrial sector and civil society, evaluate and coordinate policies for carbon neutrality.

Figure 2.1. Organisation of the 2050 Carbon Neutrality Commission



Source: CNC website (https://www.2050cnc.go.kr/eng/contents/view?contentsNo=37&menuLevel=2&menuNo=58#)

Sectoral scenarios to reach carbon neutrality by 2050

At the end of 2021, CNC announced the 2030 Nationally Determined Contribution (NDC) and 2050 Carbon Neutral Scenarios in cooperation with government ministries. These scenarios project the future of Korean society and economy as well as the sectoral transformations needed to realise carbon neutrality (Table 2.1).

The first scenario (plan A) minimises the gross GHG emissions to be offset via emission absorption or removal (80.4 MtCO_2eq.). It includes completely halting fossil fuel power generation by 2050. Emissions are absorbed or removed through sinks such as forests and CCUS.

The second scenario (plan B) projects higher gross emissions in the year 2050, notably in power generation and transport. As in plan A, it is projected that coal power generation will be stopped by 2050 but LNG-based power generation is partially maintained for flexible power use. In plan B, CCUS therefore plays a bigger role to reach net zero. CCUS is not yet deployed at scale world-wide.

These scenarios are not legally binding. However, they suggest directions for sectoral policies, as well as indications to support the development of GHG reduction technologies, and the speed of social transformation. Since the social, economic, and technological conditions related to carbon neutrality are changing, the scenario needs to be updated to reflect the situation at regular intervals.

Table 2.1. Korea has two scenarios to reach 2050 carbon neutrality

Korea's emissions scenarios to meet the 2030 NDC and the 2050 carbon neutrality.

	Sector	Base year (2018)	2030 NDC	2050	
				Plan A	Plan B
Net emissions (Mt)		686.3	436.6	0	0
Emissions	Energy transformation	269.6	149.9	0	20.7
	Industry	260.5	222.6	51.1	51.1
	Buildings	52.1	35	6.2	6.2
	Transportation	98.1	61	2.8	9.2
	Farming, Livestock, Fishing	24.7	18	15.4	15.4
	Wastes	17.1	9.1	4.4	4.4
	Hydrogen	-	7.6	0	9
	Others (accidental discharge, etc.)	5.6	3.9	0.5	1.3
Gross emissions (Mt)		727.7	507.1	80.4	117.3
Absorption and removal	Natural carbon sinks	-41.3	-26.7	-25.3	-25.3
	CCUS	-	-10.3	-55.1	-84.6
	International credits	-	-33.5	-	-7.4

Source: Carbon Neutrality Commission (2021)

The main policy directions of each key sector are as below.

The share of electricity generation from renewable energy is projected to increase to 70.8% and 60.9% in each scenario respectively. Solar and wind will be most important, with solar taking the lead. Offshore wind generation may contribute 27.5% to renewable electricity generation. Korea's share of renewable electricity generation is the lowest among IEA countries at 7%. Much energy use needs to be electrified to move to carbon neutrality, so electricity generation needs to expand massively. Plan A requires 1257.7 TWh and plan B requires 1208.8 TWh in 2050, more than twice the total electricity generated in 2018 (570 TWh). Renewable electricity generation would hence need to be multiplied roughly 20 times from current levels. A substantial share of this expansion will need to occur in rural regions, where more land is available, especially for large-scale installations. This requires consultation processes with rural residents. Engagement of regional and local governments has shown to help design policies targeted to local needs (OECD, 2023[20]).

Strong action to reduce energy demand across Korea and across sectors of the economy will limit pressure on the needed expansion of renewable capacity and the resulting pressures on rural land and infrastructure as well as related costs. Such action should for example include steps to move to circular economy practices in industry, refurbish buildings to improve their energy efficiency as well as a shift from individual car use to shared transport modes especially in urban contexts.

In the industrial sector, hydrogen-based steelmaking is introduced in Plans A and B. In plan A, by 2050, 100% is green and 20% produced locally. In plan B, more than 90% is green and 11% produced locally. Fossil fuels and raw materials used in cement, petroleum and oil refining, chemicals will be converted into renewable fuels and raw materials, with a reduction of emissions of 80.4% by 2050 in both scenarios. Korea provides scenarios illustrating potential decarbonizing pathways (Box 2.2).

Box 2.2. Future long-term scenarios for selected manufacturing sectors and infrastructure – Korea's Carbon Neutrality Scenarios for Industry

Steel

The 2050 scenarios project that coke use in furnaces to produce basic iron will be replaced with 100% hydrogen. Existing furnaces will be converted to hydrogen reduction furnaces. Direct reduction iron (DRI) made with hydrogen will be melted in electric furnaces, while expanding iron scrap use in electric furnaces. Through this, the steel industry emissions in 2050 will be down by about 95%.

Cement

The 2050 scenarios predict that solid fossil (bituminous coal) fuel will be completely replaced by waste synthetic resins (60%) and hydrogen heat sources (40%). In term of raw materials, limestone, which generates process emissions in cement production, will be partly replaced by slag, ash, and others. Through this, the cement industry's emissions in 2050 are expected to decrease by 53% from 34.1 million tons (2018) to 16.1 million tons.

Petrochemical industry and refinery

It is predicted that by 2050 57% of existing fuels will be converted by adopting electric furnaces or biomass boilers. For raw materials, 52% of fossil-fuel based raw materials for naphtha production will be converted to biomass and hydrogen. In addition, a method of pyrolyzing waste plastic and using it as a raw material is also projected. Through this, emissions in 2050 are expected to decrease by 73% from 62.8 million tons (2018) to 16.9 million tons.

Infrastructure

Hydrogen

In 2050, hydrogen demand is estimated to be between 27.4 and 27.9 million tons. The amount required for energy transformation in power generation and the production of synthetic fuels is 13.5~14.2 Mt, in industry 10.6 Mt, in transport 1.5~2.2 Mt, and to meet energy needs in carbon capture and use (CCU) 1.0~1.6 Mt. More than 80% of the demanded hydrogen is expected to be imported from abroad.

CCUS

In 2050, 85.18 million tons of CO_2 are expected to be reduced annually through CCUS. For CCS, up to 60 million tons will be processed through domestic and foreign storage annually. As a result of analysing the seabed around the Korean Peninsula, the domestic storage capacity is expected to be about 1 billion tons. Up to 30 million tons annually can be processed in domestic storage. The other half will be processed through overseas storage. For CCU, 25.2 million tons of carbon dioxide will be utilized through chemical/biological conversion and mineral carbonation technology.

Many of these decarbonisation levers are long-term and rely on technologies that are not yet available at scale yet. Korea announced its strong commitment to increase R&D for innovative technologies. Detailed plans for nearer term action have yet to be announced.

Source: Carbon Neutrality Scenario (2021)

In the building sector, Korea proposes a plan to reduce emissions by 88.1% compared to 2018 by providing energy-efficient equipment while improving energy efficiency of buildings through zero-energy building construction and renovation (Box 2.3).

In the transport sector, Plan A expands the supply of zero-emission vehicles such as electric and fuel cell vehicles to more than 97%. Plan B increases the supply of zero-emission vehicles somewhat less, to around 85%. It assumes that innovative technology will allow some internal combustion vehicles to neutralize their carbon emissions using synthetic fuels.

Box 2.3. Carbon Neutrality Roadmap (2021) of the Ministry of Land, Infrastructure and Transport

In December 2021, MOLIT presented its sectoral policy priorities for net-zero emission in 2050 in their roadmap. According to the Carbon Neutrality Scenario (2020) by CNC, the building and transportation sectors contributed 21% of total direct emission in 2018.

1. Building Sector

MOLIT is creating a management system for buildings based on the emissions throughout their lifespan (life-cycle emissions), using energy performance data. MOLIT will also promote zero-energy consumption for new buildings and green remodelling of existing buildings. In response to the enhanced NDC target for 2030, MOLIT plans to accelerate making zero-energy construction of apartments mandatory- 2023 for the public sector and 2024 for the private sector.

2. Transport Sector

MOLIT is focusing on three approaches. Firstly, MOLIT promotes the replacement of 500,000 business-use vehicles with eco-friendly vehicles by 2030, including buses, taxis, and trucks. Eco-friendly vehicles include hybrid vehicles, low-emission vehicles, and zero-emission vehicles. To accelerate the replacement, MOLIT is offering incentives, such as subsidies for alternative fuel purchase and better access to dedicated charging infrastructure. Secondly, MOLIT encourages the use of public transport by reinforcing bus rapid transit systems, transfer hubs, and metropolitan buses (intercity bus service). Lastly, MOLIT will continue to manage travel demand for passenger vehicles by offering discounts on parking fees for eco-friendly cars and imposing traffic restraint on internal combustion engine vehicles through no-drive days.

3. Land and Cities

MOLIT is establishing a carbon database, especially for rural regions, by creating a CO2 emission and emission absorption map that visualizes the amount of CO2 emitted and absorbed in each area. Furthermore, MOLIT has amended laws and rules to incorporate carbon neutrality transformations in territorial and urban plans. It aims at creating carbon-neutral settlements where all the transformations will be reflected in a comprehensive manner for buildings, transportation, energy, recycling, etc.

To support emission reductions abroad, MOLIT is planning to identify pilot projects every year that can be implemented by using domestic technologies in the fields of land, infrastructure and transport. The project examples include large-capacity public transportation systems using green hydrogen and module-based LNG infrastructure technology.

Source: MOLIT's presentation during the net-zero conference (2022)

The contribution of carbon sinks to emission reduction

Korea's draft 2050 net zero pathways plan a LULUCF sink of -25.3 MtCO2e in 2050. The document lists strengthening forest circulation management and expanding afforestation and reforestation. As mentioned in the country's updated 2030 NDC, Korea will maintain and improve its carbon sinks with sustainable forest management, conservation and restoration and by increasing green urban spaces. In 2021, the Korea Forest Service announced a reforestation plan. Payments for ecosystem services are one tool to protect ecosystems and provide resources to rural regions (Box 2.4).

Box 2.4. Payments for ecosystem services (PES)

Payments for ecosystem services (PES) are most likely to be effective in intensive farming and if they are outcome oriented. Afforestation, conversion of cropland to grassland and reduced tilling are the options with the highest potential. The conservation of high-carbon ecosystems, such as peatlands, wetlands, mangroves, and forests, has an immediate impact on carbon emissions from land use. Afforestation, reforestation, and peatland restoration need to be scaled up quickly to ensure that they can still contribute to net-zero emission objectives. Sustainable management of forests and biofuel crops can play an important role in reducing emissions, especially in sectors difficult to decarbonise otherwise, by allowing the use of biomass firing and timber. Firing biomass from sustainably managed forests and bio-crops can also contribute to negative emissions if combined with carbon capture, use and storage. Access to CO_2 storage and the most suitable sites for BECCS plants is key for this purpose. Satellite imagery, sensors and other digital tools may be required to identify where practices such as afforestation have the desired effects.

Source : (OECD, 2021[3])

Participation of local governments

Municipal governments are actively participating in carbon neutrality initiatives. A momentous milestone was set when all 226 municipal governments in Korea, including both urban and rural areas, declared a "Climate Crisis Emergency" on 5 June 2020. A month later, a consultative body called the "Carbon Neutral Local Government Action Solidarity" was formed to use and disseminate the best practices for net-zero emissions, promoted by municipal governments. According to the Climate Neutrality Framework Act, local governments have become responsible for establishing a basic plan for carbon neutrality, formulating and implementing climate crisis measures, and designating officers in charge of carbon neutrality. Under this act, the central government of Korea can also provide financial support for the creation of carbon-neutral cities and energy transition initiatives promoted by local governments, as well as for the designation of special districts for the just transition.

Despite these positive actions, there are still areas that need to be improved. Currently, local governments are enacting ordinances to enforce mandates in line with this Framework Act, but limitations such as the lack of authority, budget, and qualified local government staff are holding them back from taking effective steps to reduce GHG emissions, taking into account the characteristics of their regions. Civil society has launched a campaign to enact ordinances on carbon neutrality and climate justice, demanding an emissions reduction of 50% rather than the current 40% for the 2030 NDC target. However, local goals in local ordinances cannot be more ambitious than national goals set in national laws under the Korean legal system. Therefore, those local goals may not be included in the legally binding ordinances but just in the administrative plans of local governments.

In local elections held nationwide in June 2022, the pledges candidates for metropolitan and municipal government leadership submitted to the Election Commission showed that their commitment to climate and environmental issues was very low. It was even lower among the elected. Therefore, efforts to raise awareness of the urgency of the net zero transition would be useful. These efforts could include the Commission for Climate Neutrality (CNC), public officials of those local governments and associations of those communities.

Recent developments

As the Carbon Neutrality Framework Act took effect this March, CNC and ministries are working to establish a national basic plan within a year. This national basic plan, which will provide a basis for the plans of smaller administrative units, is set to be implemented over a period of 20 years.

As the new administration took office in May 2022, some policy changes have been made. According to the New Government Energy Policy Direction announced in July 2022, the new administration is considering abolishing the previous administration’s policy to phase out nuclear power plants by raising the target portion of nuclear energy in 2030 to over 30% from the previous 23.9%. In addition, it plans to expand research and development efforts in green technology and the participation of third parties in carbon trading markets, and to promote green finance on the basis of environmental, social and governance (ESG) criteria.

3 Employment and the Just Transition

Reaching carbon neutrality will bring profound social and employment transformations. Rural regions may be more vulnerable than urban regions due to weaker socio-economic characteristics, less economic diversification and specialisation on sectors facing global competition (OECD, 2021[4]). Manufacturing sectors facing particularly large transformation challenges on the way to climate neutrality are significant employers in rural regions. While some sectors may shed jobs, the transition should also bring new jobs, but losses and gains may not be in the same regions and sectors.

In Korea, civil society and trade unions have long demanded a just transition. The Carbon Neutrality Framework Act that took effect in March 2022 included the legal definition. It demands establishing a social safety net for climate action, designating special districts for the just transition, providing support for transition to green industries, and setting up and operating support centres (Box 3.1).

Box 3.1. The Just transition in Korea's Carbon Neutrality Framework Act

Definition

The term "just transition" refers to policy-settings for protecting workers, farmers, small and medium entrepreneurs, and other groups considered vulnerable. In regions or industries that could suffer direct or indirect loss of activity or jobs during the transition to a carbon neutral society, these policies should ensure that the risks and costs to the vulnerable social groups are minimised.

Preparation of Social Safety Network for Climate Crisis

Government shall identify vulnerable social groups, regions and industries where socioeconomic inequity may worsen, such as from job losses, impacts on the regional economy, and shall prepare support measures as well as strengthen resilience.

Government shall conduct a regular survey on the impacts on employment and prepare measures to support labour transitions (re-training, re-employment, change of occupation, etc.) to minimize costs for vulnerable groups caused by business conversion and structural unemployment.

Special Districts for Just Transition

Government may designate any of the following areas as a special district during transition to a carbon neutral society following deliberation by CNC:

1. An area in which the employment environment has changed or is likely to change significantly due to rapid job losses, regional economic slump, and changing industrial structures.
2. An area which is expected to experience or has experienced rapid socio-economic changes.
3. Any other area which CNC designates to resolve a possible socioeconomic imbalance.

Government shall establish and implement measures for special districts including support measures for job security, business activity (e.g., R&D, commercialization, domestic and overseas marketing), investment for new businesses, creating jobs with other administrative or financial support measures to facilitate the conversion of industry and employment, or tax benefits.

Support for Business Conversion of SMEs

Government may provide support to SMEs in activities which are vulnerable during the transition to a carbon neutral society to help their transformation efforts.

Just Conversion Support Centre

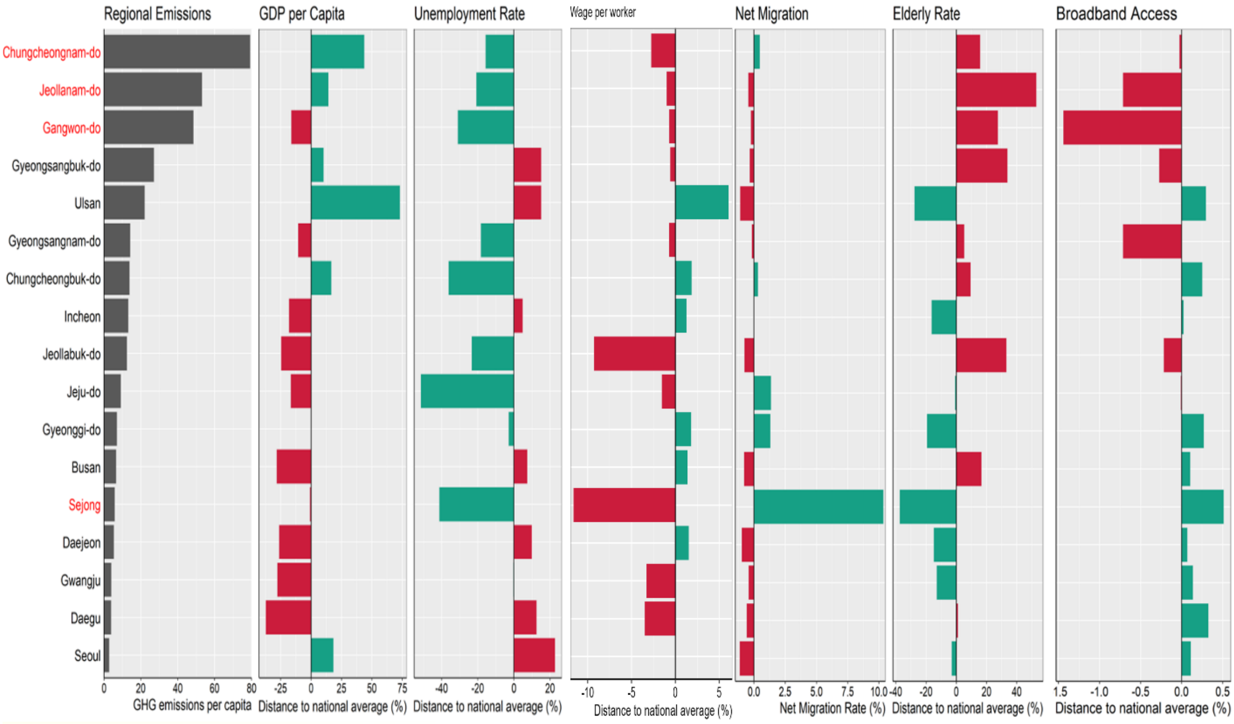
Central and local governments may establish and operate a just transition support centre to provide necessary support (e.g., surveys on the impacts on jobs and local communities; research for the conversion of industry, labour, and local economy, job conversion models; education, training and support for conversion of jobs; consulting and support for business conversion of enterprises; proposal of improvement of relevant statutes, regulations, and systems).

Source: Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis

Korea's rural regions perform well on some socio-economic characteristics (Figure 3.1). In most rural regions GDP per capita is higher than the national average. Additionally, the unemployment rate of the rural regions is lower. However, Korea's rural regions lag in other aspects. Wages in all rural regions are lower than the national average, even when Seoul, where wages are much higher, is excluded from the national average. Wages are on average particularly low in Chungcheongnam-do, the region with highest per capita emissions, and in Sejong. Low wages make it harder for workers to absorb economic shocks that may arise from the transition. They may also have fewer own resources to retrain. Low or negative net immigration suggests poor regional attractiveness. In Korea, only some urban regions experience positive net migration. Sejong is an exception as it is quickly urbanising. The rural regions also have among the highest shares of elderly populations. Broadband access is relatively weak. Poorer broadband access diminishes opportunities to diversify regional economies away from carbon intensive activities (OECD, 2020[21]).

Figure 3.1. Korean rural regions are lagging in wages, net migration, elderly rate and broadband access

Relative distance of socio-economic indicators of Korean TL3 regions from the national average



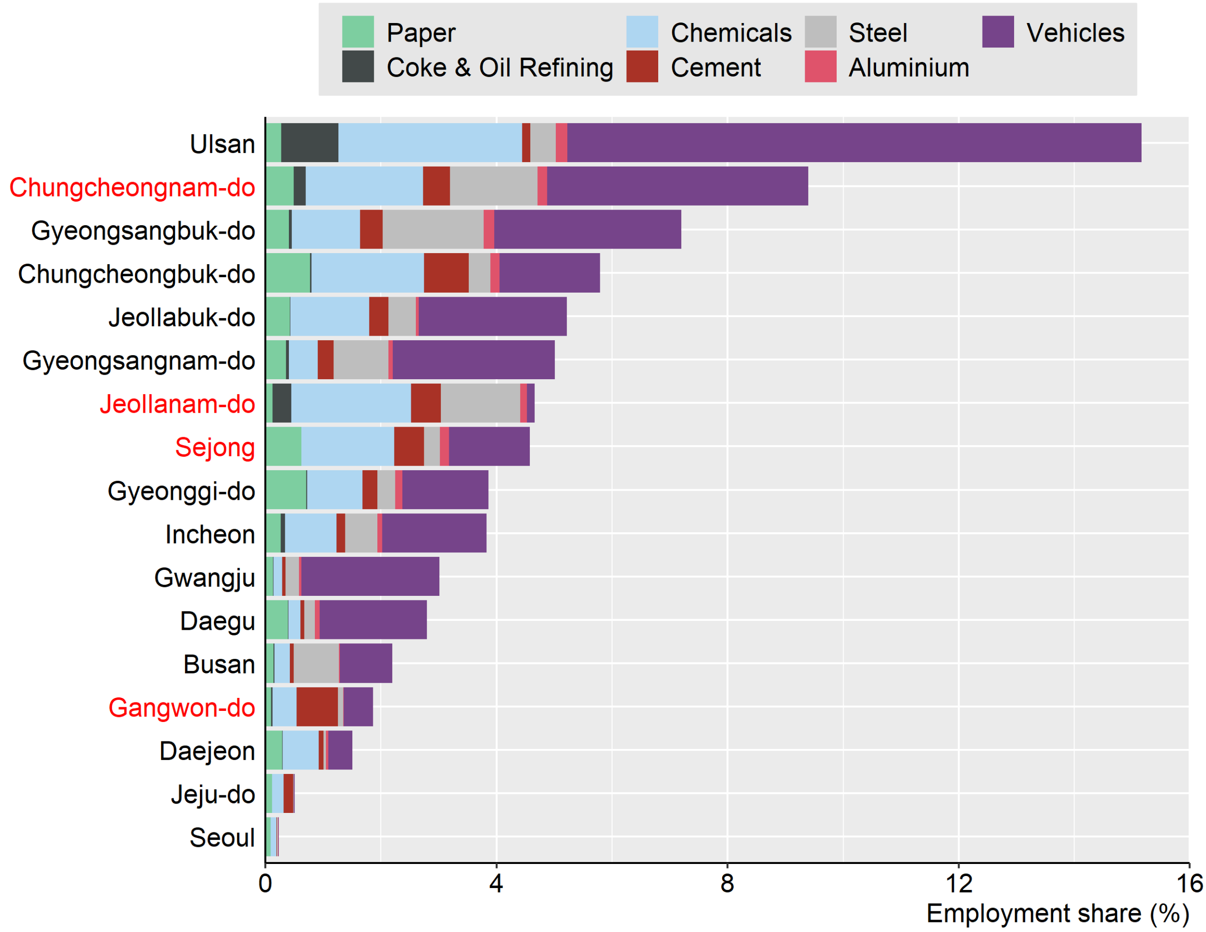
Note: All indicators are the relative distance to the national average except for net migration. The national wage average does not include Seoul, as wages in the capital region are much higher and distorts the average. Net migration is the regional net immigration rate, per cent of the regional population. The elderly rate refers to the share of the population above the age of 65. The names of rural regions are in red.
Source: KOSIS (2019).

The high GDP per capita and low unemployment rates of rural regions may be due to their strong manufacturing base. In Chungcheongnam-do, manufacturing generates 50% of the regional value added and accounts for 25% of the regional employment share. The other rural regions also rely on manufacturing for big contributions to value added and regional employment. Korean rural regions are less economically diversified than urban ones and are highly specialised in the manufacturing sectors (OECD, 2021[4]). The lack of economic diversification increases their vulnerability as manufacturing sectors will have to face particularly large transformations to become climate neutral. Economic diversification of regions increases the resilience of regions overtime (OECD, 2023[20]).

Employment in the six manufacturing sectors facing particularly large transformations, as identified in the previous chapter, is large in Korean regions. In Chungcheongnam-do, the six sectors provide more than 9% of regional jobs, with vehicles, chemicals, and steel having the biggest shares (Figure 3.2). Experience with other transitions in OECD countries, such as the transition out of coal and digital transition, suggest that risks of job losses may be greater in rural areas, and new opportunities are more likely to be found in urban regions (OECD, 2023[20]). Additionally, capacity to access the necessary production technologies, skills and investments can differ substantially across regions (OECD, 2023[14]). Hence, rural regions need to be prepared to mitigate the shocks that will arise from the transition.

Figure 3.2. Employment shares in vehicles manufacturing and chemicals are high in rural regions

Employment shares of hard to decarbonize sectors in TL3 Korean regions, 2019



Note: The names of rural regions are in red.
Source: KOSIS (2019).

Sectoral employment impacts from moving to carbon neutrality

To ensure a just transition, Korea and its rural regions need to understand where the biggest employment losses will occur and where the employment opportunities will arise. The dynamic equilibrium ENV-Linkages model illustrates potential employment impacts of climate mitigation action with sufficient ambition to reach the Paris agreement targets in Korea due to the transition (Box 3.2). The model highlights the sectors in which employment losses and employment gains are expected.

Box 3.2. Simulating employment impacts from emission reductions consistent with the Paris agreement.

To understand in which sectors employment may change, due to climate mitigation policy, simulations from the dynamic general equilibrium OECD ENV-Linkages model are used. General equilibrium modelling allows to consider both direct and indirect effects, nationally and internationally, for example, as a result of changes in intermediate product demand. OECD ENV-Linkages illustrates economic impacts in the future, linking economic activity and employment to the costs of reducing GHG emissions.

The simulations draw on the IEA's 2018 Sustainable Development Scenario (SDS), where countries reach the objectives of the Paris climate agreement and are on track for some key sustainable development goals. The IEA SDS is based on a surge of clean energy policies and investments. The sectoral employment outcomes consistent with the SDS in 2040 are compared to the sectoral employment outcomes of a hypothetical baseline scenario of no further climate policies to derive the impact of climate mitigation action.

Source : (Bibas, Chateau and Lanzi, 2021[22])

The sectors most related to coal, oil and gas extraction and use should expect the biggest employment impacts, but employment shares in these activities are very small. Employment in thermal power generation, which includes generation from coal, oil and gas, may decrease by 61% (Figure 3.3). The rural regions currently have some regional employment in this sector, with Chungcheongnam-do having the largest share of 0.5%.

Figure 3.3. Korea's rural regions may experience employment losses in some sectors

Simulated selected sectoral employment impacts in Korea by 2040 from emission reductions consistent with the Paris agreement and corresponding sectoral employment shares in Korea's rural regions.

Sector	Employment impacy (%)	Employment share (%)			
		Chungcheognam-do	Gangwon-do	Jeollanam-do	Sejong
Coal extraction	−100	...	0.25	...	...
Thermal power generation	−61	0.50	0.17	0.13	0.31
Natural gas distribution	−53	0.05	0.09	0.05	...
Petroleum and coal products	−35	0.21	0.02	0.32	...
Chemicals, rubber, plastic products	−32	4.28	0.74	2.88	2.92
Water collection and distribution services	−8	0.09	0.15	0.14	...
Pulp, paper and publishing	−7	0.63	0.42	0.33	1.00
Textiles	−6	0.40	0.11	0.20	0.11
Electronics	−6	3.90	0.10	0.09	1.68
Non-metallic minerals	−6	0.08	0.97	0.90	1.56
Primary aluminium production	−5	0.17	0.00	0.12	0.16
Electricity transmission and distribution	−5	0.03	0.06	0.02	...
Other manufacturing	−4	0.19	0.30	0.19	0.24
Fisheries	−3	0.01	0.02	0.36	...
Oil seeds	3	...	...	...	...
Air transport	7	...	...	0.00	...
Secondary iron and steel	7	...	...	...	...
Hydropower	19	...	0.05	0.00	...
Wind power	19	...	...	...	...
Solar power	71	0.02	0.03	0.07	0.01
Other power	175	...	...	...	...

The sectoral employment impact is computed as the difference between the employment consistent with emission reductions to meet the Paris climate targets and a baseline scenario with no further emission reduction action. See Box 3.2

Source: (Château, Dellink and Lanzi, 2014[23]) and KOSIS (2019).

Chemicals, rubber and plastic products provide substantial employment in several rural regions, reaching 4% in Chungcheongnam-do. The sector may lose 32% of its employment as a result of Paris-agreement consistent mitigation action. The manufacture of electronics equipment may experience a decrease of 5%. The manufacture of electronics can be energy and materials intensive. Circular economy initiatives may be particularly valuable in this sector but could shift employment to service sectors, including repair.

As of 2020, there are about 350,000 people in the internal combustion vehicle production sector. With the conversion to electric vehicles, the number of required workers may fall more than 30%, following estimates for European economies, reflecting the fact that electric motors are simpler to assemble than internal combustion engines (OECD, 2023[14]). Further employment loss is likely to result from the needed move to less individual vehicle use, especially in urban contexts, and to lighter vehicles, to make the transition to climate neutrality easier to achieve (OECD, 2023[14]). Actual trends point to increasing vehicle weights however. Related services, notably repair, will also be affected, because electric motors are simpler and easier to maintain than internal combustion engines (Box 3.3). However, vehicle manufacturing may not shed employment in Korea on aggregate according to the modelling results and may even increase slightly, for example through battery production.

Box 3.3. Challenges for Jeju's Carbon Free Island Policy

Jeju has implemented a Carbon Free Island Policy since 2012. This policy is to supply all electricity with renewable energy and replace all cars in Jeju with hydrogen cars and EVs by 2030. The share of renewable energy in Jeju's electricity mix was 16% in 2021. The share of EVs is the highest among Korean regions at 6.4% (25,571 units), compared to the national average of 0.93%.

Due to the penetration of EVs, Jeju is seeing a rise in the importance of job conversion at gas stations or repair shops for internal combustion engine vehicles. According to the Ministry of Employment and Labor and the Korea Energy Economics Institute at the end of 2021, 59 auto repair shops (13% of total) closed in Jeju between 2015 and 2019, when the EV penetration rate had risen to 5%. In the same survey, it was estimated that if the number of EVs in Jeju will increase to over 220,000 units by 2025, the number of repair shops will drop by 87%.

Given the small scale of the economy of Jeju with only around 400,000 jobs heavily dependent on tourism, farming and fishery, the expected loss of more than 6,000 jobs caused by the closure of auto repair services may cause social problems in the community.

The provincial government of Jeju put this issue under the review of the Ministry of Employment and Labor for employment impact assessment in 2022 to assess the impact of its EV promotion policy on regional employment. It is planning to come up with a conversion plan for the workers in the internal combustion vehicle industry and related services under the government's leadership, evaluating effectiveness both in terms of quantity and quality of employment.

Renewable electricity and circular economy job opportunities may counterbalance the employment losses. Employment gains will occur in solar power, wind power, hydropower. Current employment in these sectors is very small, but the job growth rates are big. Employment in solar power is expected to grow by 71% and hydropower and wind power by 20%. Renewable energy, especially wind power and solar PV, are more labour and land intensive than fossil-fuel power. This suits rural regions that have more land available and higher employment in fossil fuel generation that needs to shift. Given that Korea is mountainous rooftop solar PV is particularly important, which in turn has higher job creation potential than utility scale solar PV. In the circular economy, employment gains of 7% are expected in the manufacture of secondary iron and steel. According to Climate Analytics, job losses related to coal phase out in all regions of Korea will be outweighed by newly created jobs in renewable energy and related storage technologies (2021[24]).

The Korean just transition support plan

Against the backdrop of expected employment impacts, the Ministry of Employment and Labour (MOEL) announced a just transition support plan. The plan pushes for policies allocating a total of one trillion KRW budget in 2022, including job transition and career change support.

To accurately grasp the labour transition MOEL will introduce a regional and sectoral alert system. MOEL's 'Digital Job Map' will support the movement of workers in the labour market by identifying transitioning industries at an early stage and forecasting employment changes through enterprise database analysis. The Digital Job Map visualizes changes in jobs by region and industry, thus helping MOEL respond accordingly. The map is scheduled to be piloted in the specialized car industry area (Ulsan region) in 2022 and will be expanded nationwide in 2023. MOEL will also conduct an employment impact survey for the coal power plants before their closure and require the companies concerned to establish an employment stability and job transition plan encompassing workers and sub-contracting companies.

MOEL will identify companies with the biggest need for business and labour transition, providing support along 4 axes:

- **Diagnosis** – Identify companies in need of support through various channels (Korea Chamber of Commerce, government agencies, industrial associations, etc.), and specialized public agencies (e.g., Korea Chamber of Commerce, Korea SMEs and Startups Agency, to be designated in 2022) and provide diagnoses, for example to determine when a company needs to transition and whether it is eligible for support programs.
- **Consulting** – Specialized public agencies provide guidance on using appropriate government support programs and consultation for business and worker needs in the transition based on diagnostic results.
- **Establishment of transition plan** – Companies establish action plans for their transition.
- **Follow-up** – Provide customized support to the transition efforts, and follow-up with continuous monitoring, analysing success and failure cases.

It will expand specialized training for job conversion and career change support and strengthen the tailored support for enterprises. A "special employment support team" will be set up at regional employment centres for workers who may be displaced. They will be able to receive re-employment support, career counselling and vocational training. In addition, MOEL is planning to introduce legislation to this effect.

Finally, MOEL will prepare the institutional framework for social dialogue to support the labour transition. It will involve worker representatives, management, and regional stakeholders. For example, when the Honam coal Power Plant was closed in December 2021, the special employment support team at the local employment centre supported reemployment of displaced workers and social dialogue, such as several meetings to discuss support for workers. Chungcheongnam-do has in addition developed its own just transition initiatives (Box 3.4).

Box 3.4. Just transition initiatives in Chungcheongnam-do

The just transition agreement

With the province's dedicated efforts, unit 1 and 2 coal power plants in Boryeong were closed in December 2020, 17 months earlier than the original plan. This destroyed 526 jobs. In the long term, at least 5,294 workers in power generation companies and business partners are estimated to be affected. To minimize any impact, Chungnam signed an agreement with the town of Boryeong and power generation companies on maintaining employment and compensating tax revenues. The agreement helped redeploy workers, repurpose facilities, and minimise unwanted relocation of workers to other regions. For the tax revenue loss of the Boryeong, Chungnam province has compensated KRW 1.7 billion over the period of two years.

Measures to provide worker safety nets

A total of KRW 40.9 billion is allocated until 2025 to support workers in high-risk industries. Eight organizations are participating in this project, mainly for coal power generation and internal combustion car parts industries. This measure provides workers leaving their jobs with services including job matching, psychological counselling, and job requirement testing, as well as career change incentives. In addition, it provides customized training to enable workers to move to industries producing eco-friendly car parts and offshore wind power plants. It also provides support for the transition to environmentally friendly industries, including consulting services for businesses to meet environmental regulation and training for design engineers.

Attracting new businesses to transform local industries

Chungnam is promoting the eco-friendly automobile industry, supporting the local energy transition, establishing blue hydrogen plants, as well as building large-scale offshore wind farms.

Just Transition Fund

Chungnam set up a fund to support the areas affected by the closure of coal plants and minimize the negative impact of the energy transition on the local economy.

Chungnam aims to raise KRW 10 billion for the Just Transition Fund over five years from 2021 to 2025. Eight entities are contributing to the fund every year – Chungnam province (30%), four cities and counties where coal plants are located, and three power generation companies (10% each). This fund will be used mainly for regional impact analysis, job security and job transfer projects, and social dialogue programs.

The fund has accumulated KRW 2.5 billion in 2022. Chungnam has built a community with participants including workers and residents and is exploring projects for the region.

In 2021, Chungnam selected two projects to be funded. One is about the analysis of potential damage from large-scale offshore wind farms to the regional fishing industry. Another is the establishment of a basic plan to develop a cluster for the hydrogen industry. In 2022, Chungnam is planning to conduct projects on the designation of special districts for the just transition, discussions on just transition for energy, and support for job transfer in line with just transition allocating KRW 2.5 billon in next five years.

Source: Chungcheongnam-do's presentation during the net-zero conference (2022)

Conclusion

As the conference "Rural Transitions to Net Zero GHG Emissions in Korea" has revealed, Korea's rural regions play an important role on the path to climate neutrality. Among OECD rural regions, Korean rural regions have the highest emissions per capita, and they have grown strongly. These trends will need to reverse sharply, suggesting that the transformations will be particularly intense for their populations. The share of GHG emissions from rural regions is higher than in the OECD on average.

A particularly large share of the emissions in Korean rural regions arise from power generation, mostly from coal use. Power generation will have to decarbonise particularly quickly, as other sectors, such as transport, will rely on electricity to meet energy-needs carbon neutrally. Korea will also need to rely on rural regions' potential for renewable electricity to replace carbon-intensive electricity generation and meet increasing electricity demand. Governance mechanisms that allow local populations to share in decision-making and in profits can help. Efforts to reduce energy demand in Korea can reduce the pressures on carbon-free electricity generation, which may fall particularly strongly on rural regions.

A high share of emissions in rural regions, compared to the OECD, also arises from manufacturing sectors. These are particularly hard to decarbonise, including automobile production, chemical and steel. They provide a big number of high-quality jobs, in regions where wages are already low. In some of these sectors Korea may face the risk of some employment loss.

As in other OECD countries, Korea's rural regions face specific challenges in the transition, including a more vulnerable, older population, limited economic diversity and lower quality digital infrastructure than urban regions. Unlike in other OECD countries, GDP per capita in Korea's rural regions is higher than the national average, but wages are often lower. Past transitions in OECD countries illustrate that risk of job loss is greater in rural areas, and new opportunities are more likely to be found in urban regions (OECD, 2023[20]) The regional development and just transition implications for rural regions therefore require particular attention.

As a result of these discussions, the conference has highlighted multiple place-based policy avenues:

- Clear regional **investment signals** in the direction of climate neutrality by 2050 are essential. For example, this should include a clear phase out date for coal power generation around 2030. Clear signals can encourage appropriate investment decisions. Making sure investment is consistent with the transition to carbon neutrality prevents unnecessary costs. It may also allow workers to take different career decisions early on, which reduces adaptation costs. Stronger near-term action to reduce GHG emissions is also needed to strengthen the perceived credibility of the longer-term targets and objectives, thereby reinforcing guidance for investment decisions. Key action benchmarks referred to in the conference can provide orientation in this respect (Box below).

Some Paris-consistent international scenario benchmarks

- Need to speed up phase out coal by 2030 in electricity generation.
- Need to speed up phase out natural gas by 2050 in electricity generation.
- Raise the share of renewables in electricity generation to 61% by 2030, while raising electricity supply to meet energy needs.

- Manufacturing emissions need to fall 2.3% annually by 2030.
- End the sale of new internal combustion vehicles, including hybrid vehicles, by 2030-2035.

- Policy makers need to **proactively involve rural regions** in policy discussions to reinforce low-cost climate actions suitable to rural contexts, such as for zero-emission mobility, and engage local populations. Low-cost solutions are especially important for rural regions, where wages are lower and car dependence higher. For example, rural residents may benefit from electric vehicles' low operating costs with appropriate policies to deploy charging infrastructure, which are particularly important in rural regions. Much of the needed massive expansion of low-cost renewable energy needs to be deployed in rural regions. This requires consultation processes with rural residents. Engagement of regional and local governments has shown to help design policies targeted to local needs (OECD, 2023[20]).
- Rural regions are key **to improve the assessment of just transition impacts.** Extensive regional employment impact assessment is necessary to accompany policymaking. Korea has advanced in developing regional policy tools and can offer insights to other countries. A spatial analysis of sectoral emissions in activities facing the biggest transformation, especially in manufacturing, combined with an assessment of socioeconomic vulnerabilities of workers and firms would allow to assess needed local actions for infrastructure deployment and the just transition. This can also include indirect impacts to downstream activities industries (e.g., car repair) and induce active participation of stakeholders.
- The **just transition policies should focus on improving economic opportunities that are consistent with climate neutrality** rather than merely provide compensation where activities need to be phased out**.** A focus on investment and skills can provide rural populations with alternative economic opportunities. This includes creating new business opportunities with sustainable business models, rather than just focusing on existing companies.
- It is essential to foster **land use planning consistent with climate neutrality.** Land use planning needs to consider the infrastructure needed to decarbonize power generation, manufacturing, and transport. For example, spatial planning can facilitate the use of shared transport, improve accessibility to public transportation or active mobility and reduce reliance on private vehicles. The integration of sustainable land practices in agriculture and forestry is important to create carbon sinks while protecting biodiversity. Payments for ecosystem services can be one tool to make land use more sustainable and can provide resources to rural regions to this end.
- **Multilevel climate policy governance, combined with monitoring by the Commission for Climate Neutrality (CNC), can reinforce resilient regional development**. The CNC can coordinate vertical and horizontal cooperation based on clear policy goals and strategies. It can help spearhead strengthening awareness for needed accelerated climate action in rural populations. These efforts could include public officials of those local governments and associations of those communities.
- Policymakers could also consider the **developing estimates of regional consumption-based emissions.** The conference has drawn on production-based emissions. Consumption-based emissions data can help make sure regions consuming emission-intensive goods and services contribute to efforts to achieve carbon neutrality and to making consumption more consistent with carbon neutrality, for example via circular economy initiatives.

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