

What should the sub-national planning be considered to achieve carbon neutrality?

: exploring a case study in Jeju Province, South



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1. Introduction

Subnational Carbon neutral policies are essential to achieving national carbon neutrality. While national governments focus on establishing legal and institutional regulations, subnational governments establishing and implementing individual policies to which national strategies are cascaded down can be subjects of implementing substantial mitigation instruments. Therefore, assessing and quantifying GHG(Green House Gases) mitigation with subnational climate policy can clarify national carbon-neutral strategy and support national action with potential impacts of subnational climate policy.

However, some challenges exist in simulating and exploring subnational carbon-neutral policies' mitigation pathways. As national and subnational governments show differences in the governance level in establishing policies, it is necessary to explore the potential mitigation pathways of national carbon-neutral policies on a subnational scale. In addition, it is crucial to localize the national policies considering the plausibility of carbon-neutral pathways regarding economic, environmental, geological, and cultural constraints. In consideration of these conditions, this case study explored the feasible pathways to achieve carbon neutrality in Jeju Province, South Korea, to establish the carbon neutrality plan at the subnational level.

2. Method

We conduct a three-stage decision-making process with local stakeholders to explore the feasible carbon-neutral pathways of energy system in Jeju.

1. We model subnational carbon-neutral paths by adopting 『2050 Net Zero scenario of Korea』 onto Jeju subnational scale using AIM-ENUDESE. This stage shows the gap between national carbon-neutral policies and local circumstances and plausible mitigation measures to achieve carbon neutrality at a subnational level.
2. By communicating with stakeholders and decision-makers, we set plausible carbon-neutral scenarios considering local policies and constraints. It will determine Jeju's feasible and robust carbon-neutral pathway and mitigation options.
3. With the result of second stage, we explore how subnational carbon-neutral policies can contribute to near-term and long-term national mitigation targets by adjusting periodic goals and policy units.

Table1. Description of three-cycle decision-making at a subnational level

Stage 1 National carbon neutral scenario	Stage 2 Localized subnational carbon neutral scenario	Stage 3 Adjusted periodic carbon neutral targets
<ul style="list-style-type: none"> • BAU Scenario with energy demand projection of Jeju • Modelling using AIM-ENUDESE with 『2050 Net Zero scenario of Korea』 • Two scenarios conducted whether adopting hydrogen economy or not 	<ul style="list-style-type: none"> • Modelling energy system calculated by the business volume of each carbon-neutral policy unit • Considering 『2030 Carbon Free Islands Jeju』 and local constraints (economic, cultural, geological, environmental) • Three scenarios conducted, current climate policy pathway, mitigation strategies with local resources, localized carbon-neutral strategies 	<ul style="list-style-type: none"> • Modelling energy system calculated by the business volume of each carbon-neutral policy unit • Considering the result of stage 2 and set targets on each 2050, 2045, 2040 carbon neutral and adjusting short-term mitigation goals

3. Results

3.1 1st Stage(National carbon neutral scenario)

- Hydrogen energy and technologies will be major mitigation measures since 2030 because the cost of hydrogen energy will be decreased due to technology improvements and finance incentives
- All sector should consider electrification or adopting hydrogen economy to achieve carbon neutral
- However, in view of local stakeholders and decision-makers, national scenario do not include the Jeju's current climate policy and local resources(ex. sufficient space area to construct new energy sources)
- More consideration on policy building(ex. set the business volume of each carbon-neutral policy unit in each year) is needed at a subnational governance level

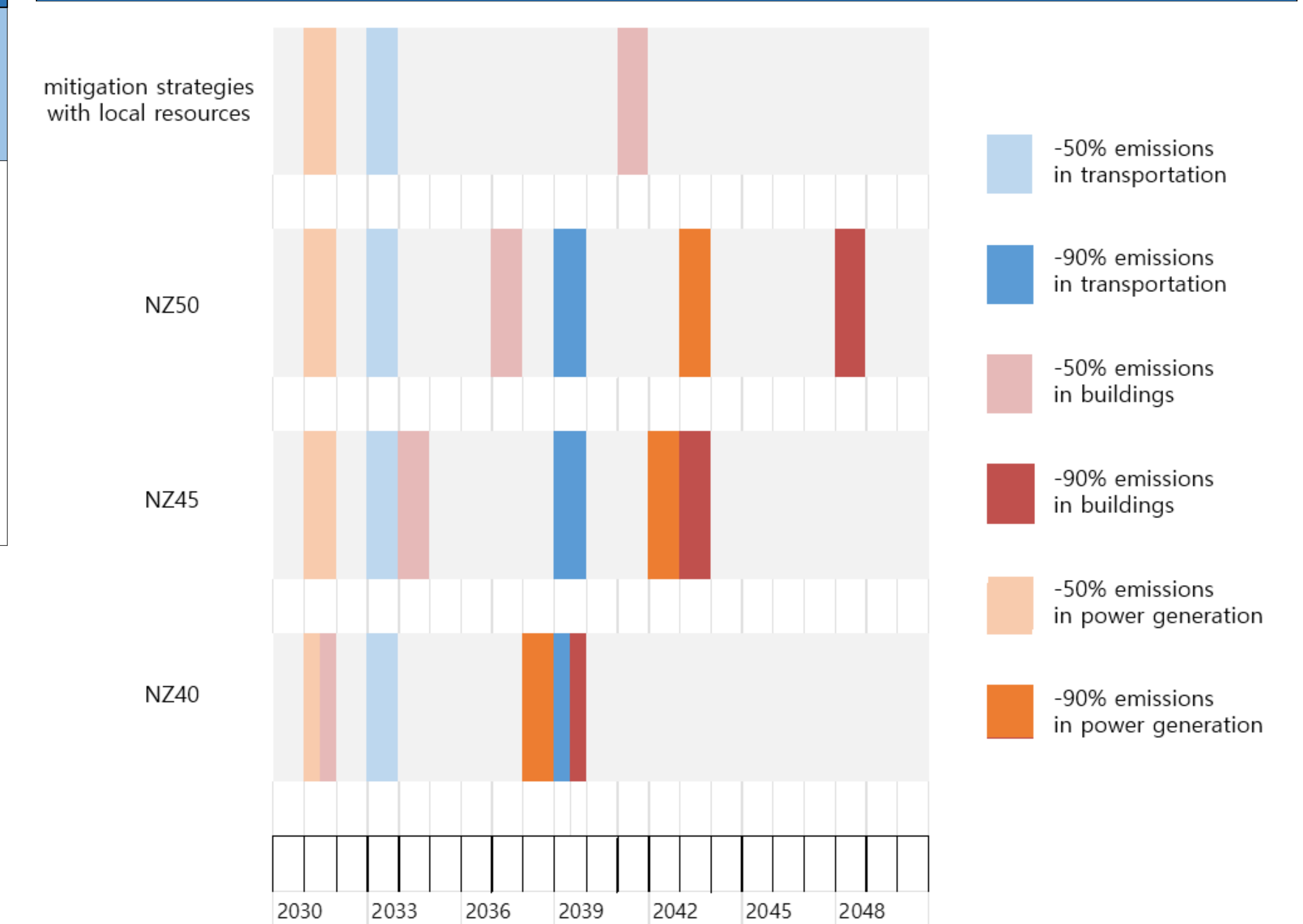
3.2 2nd Stage(Localized subnational carbon neutral scenario)

- The results of plausible scenarios of Jeju show the robust and feasible pathway to achieve carbon-neutral in Jeju
- In power sector, renewable energy will provide electricity until the market potential considering the cost of electricity generation, energy demand and space area of power plant in Jeju in 2050
- Fuel cell power and ESS will start to be the base load power of Jeju since 2030 in which thermal power will shut down
- Because of electrification in other sector, electricity demand will dramatically increase 2.73 times more than base year(2018) in 2050
- In transportation sector, along with 『2030 Carbon Free Islands Jeju』, road transportation will be carbon-neutral in 2040, however, flight and shipping transportation should be tackled at a national level
- In building sector, although district heat supply is more efficient way to reduce emissions, electrification will be major mitigation options due to the local geographical constraints to supply heat

3.3 3rd Stage(Adjusted periodic carbon neutral targets)

- Scenarios that adjust target year of carbon neutrality to explore potential contribution to national targets show that early adopting hydrogen energy will be the key measure
- Net Zero 2040 Scenario shows that it is plausible to achieve carbon neutrality in 2040, however considering rapid land use change due to constructing renewable power plant and energy security, it may cause transition risk and may not be a feasible pathway

Figure 1. Milestones of carbon neutral scenarios in Jeju



4. Discussion

With the results, hydrogen production and power generation will play a game-changer in achieving carbon neutrality considering renewable energy curtailments and the instability of renewable energy. These results seem to reflect Jeju Island's constraints to establish an independent power grid to its geographical conditions. More supports to appropriate policies regarding hydrogen are necessary in Jeju.

However, there are some distinct parts of what the national government should support to achieve carbon neutrality on a subnational scale. There are ambiguous points on aviation and shipping at the subnational scale. Also, legal and institutional support of the national government is necessary to maximize the efficiency of decentralized energy production in Jeju. More considerations on laws, regulations, standards and research and development investments are necessary to support the process of promoting subnational carbon-neutral policies.

It is required to consider dealing with local issues at a subnational level: sufficient space area to install renewable power plant, plausible scenarios considering existing infrastructure and local resources, potential risk of transition at a subnational. Feasibility of scenarios should be considered not only in aspects of the energy system but also in local issues.

To make these scenarios more practical, subnational governments should consider how to share these visions with local communities. Communicating with local communities in this research, they focused on the feasibility of these scenarios in Jeju and the uncertainties of policy effects on emission reductions. Therefore, it is necessary to continuously monitor the reduction effect and share it with the local community to promote a carbon-neutral policy. The model used in this study to quantify the emission reductions of subnational mitigation policy can be a tool to support this process.