AchiEVing carbon-neutral in local government toward 2050: Case study on Jeju Island, South Korea

Yohan Choi[1] , Chan Park[1]
1) Department of Landscape Architecture, University of Seoul

1. Introduction

With the Republic of Korea's Declaration of 2050 Carbon Neutrality, local governments in Korea should set the target to go carbon neutral by 2050. As the characteristics of energy usage have a regional difference in each sector it is necessary to establish a carbon-neutral strategy on the local lEVel to achieve carbon-neutral toward 2050. In this study, we investigated energy transition in Jeju Island on target of carbon-neutral, South Korea. As Jeju is located in the southernmost part and has different characteristics from other regions of Korea, it is essential to construct independent energy transition strategies in Jeju. This study has analysed in sector of building energy and transportation, which accont for 85% of energy use in Jeju.

Figure 1. Energy use in Jeju(2018)

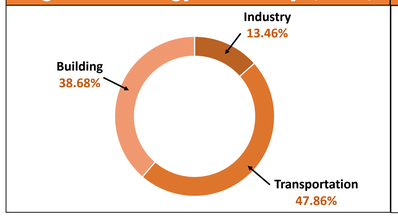
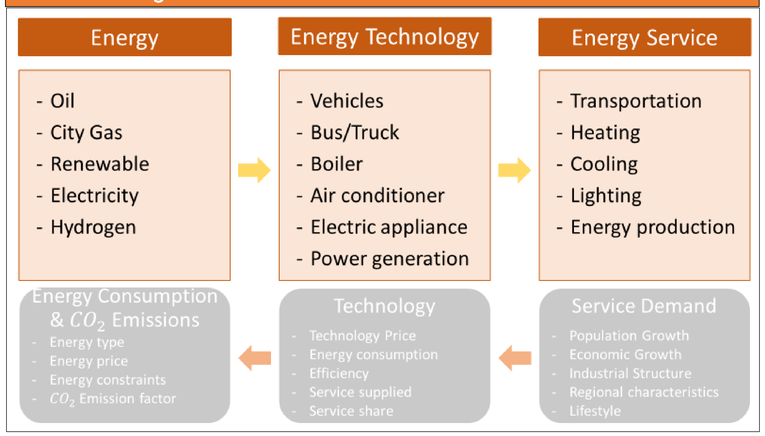


Figure 2. Map of Jeju, South Korea

2. Method

This study has constructed the energy model in sector of building energy and transportation with AIM-ENDUSE model. The model has considered the current energy use data(2018) and 2020-2030 regional energy planning in Jeju. The AIM-ENDUSE model in this study uses a technology selection framework for analysis of policies related to carbon emission mitigation and energy use.

Figure 1. The framework of AIM-ENDUSE model



In this model, each types of the oil products are modeled and each emissions, price, demand and energy-use of the oil products are also constructed. Renewable energies are assumed to generate electricity. Hydrogen generation were modeled only by the electrolysis. The model is also considered the feasibility of the energy technology. New energy technologies, such as hydrogen related dEVices, electric boiler and vehicles are regulated by service share. Energy service was calculated considering current energy-usage and socio-economic changes(population change, economic growth, energy polices, etc.)

3. Scenario

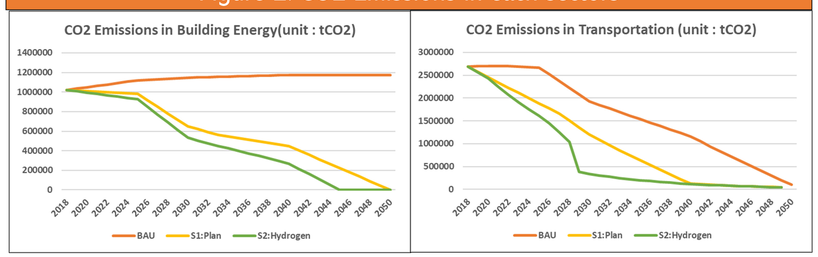
Table1. Scenario of energy transition in Jeju

BAU	Scenario1 (New strategies of energy plan in Jeju)	Scenario2 (Adopting hydrogen economy)
• With no climate policy	• City gas(LNG) supply • Electric energy use increase (ex. Vehicles, boiler) • Zero-carbon emissions in 2050	• Hydrogen energy use (ex. Fuel cells, FCEV) • Zero-carbon emissions in 2050

- BAU assumes that there is no climate policy and technology selections are computed by the cost
- In Scenario1(New strategies of energy plan in Jeju), this strategies contains LNG supply(up to 57% of heat energy demand in 2030) and electric energy use increase(considering EV Charging Station building plan, subsidy for EVs, improvement of electric boiler technology). Zero-carbon emissions in 2050 are assumed in this scenario.
- In scenario2(adopting hydrogen economy), fuel cells were estimated to produce both heat energy and electric energy with up to 80% efficiency. As Jeju governments focus on commercialization of EV, this study assumed that the penetration of FCEV in the market would be prolonged compared to the FCEB(Fuel Cell Electric Bus). Zero-carbon emissions in 2050 are also set up.

4. Results

Figure 2. CO2 Emissions in each sectors



- CO2 Emissions are increase about 14.8% under BAU scenario
- Scenario1 and Scenario2 will achieve carbon-neutral, especially, Scenario2 in 2045.

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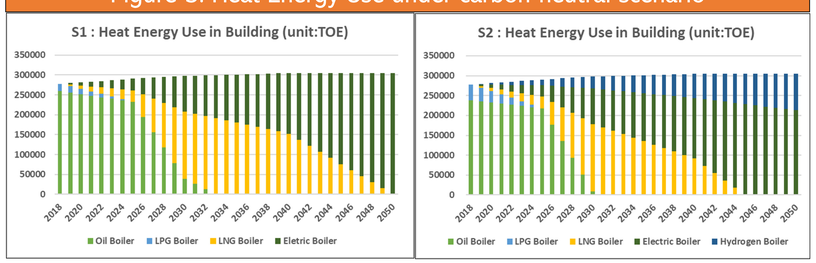
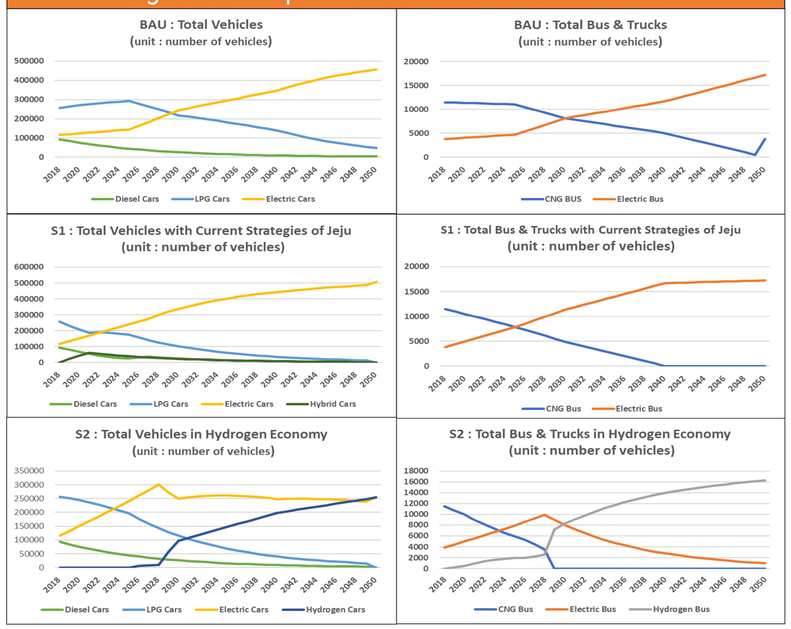
Figure 3. Heat Energy Use under carbon-neutral scenario



- Both scenario show that LNG gas will be emerged as an intermediate energy in the phase of energy transition.
- In the final energy transition phase of scenario2, fuel cells will account for 30% of the both heat energy use and electric energy use in building respectively.

Figure 4. Transportation Outlook under all scenario



- All the scenario show that EVs will penetrate in transportation sector as EVs will have competitive price around 2025
- As the constraints on CO2 emissons, scenario1 show that hybrid cars would take a role in energy transition
- In scenario2, both FCEVs and FCEBs would be increased after 2030 and FECBs will be the final energy transition phase in the market of bus and trucks

5. Discussion

This study has focused on the pathways to achieve carbon-neutral on local level. Although LNG supply will able to reduce carbon emissions, achieving carbon-neutral in building sector need other strategies such as electric boiler and fuel cell heating system supply. Also, more policies of hydrogen economy especially on hydrogen fuel cell plants and FCEBs are required to accelerate to reduce carbon emissions.
In this study, we assumed energy transition and demand considering population change, economic growth and energy policy in Jeju. However, there are some limitations on estimating energy technology. For example, technology efficiency was not reflected on the model such as digitalization and building energy efficiency. As Jeju is a major tourist city in Korea, more researches are required to predict the effects of tourism demand changes on energy system modeling.
As electric energy-usage will be increased in all scenario, more researches are required to approve the possible amounts of RE generated in Jeju. With renewable curtailment on Jeju, energy storage with ESS and hydrogen will also able to reduce generated RE loss and carbon emissions.

Table2. Renewable energy use in building energy and transportation sector

(unit : 1000TOE)	2018	2025	2030	2040	2050
BAU	58.7	228.7	652.3	935.4	1009.9
Scenario1	58.7	265.2	773.0	730.4	1017.2
Scenario2	58.7	457.5	1228.7	1583.2	1829.7

Contact : yohan0711@gmail.com, chaneparkmomo7@uos.ac.kr